FOOD TECHNOLOGY

PUBLISHED BY THE INSTITUTE OF FOOD TECHNOLOGISTS

IN THIS ISSUE

Nutritional and Biochemical Effects of Irradiation / *61*

The Development of Instant Milk / *64*

Rapid Procedures for Approximation of Bacterial Counts in Shrimp and Oysters / *66*

The Effect of High Temperature Storage on the Content of *Salmonella* and on the Functional Properties of Dried Egg White / *68*

Volatile Flavor of Strawberry Essence. I. Identification of the Carbonyls and Certain Low Boiling Substances / *73*

Moisture Distribution in Fresh, Frozen, and Frozen-Defrosted Bread / *76*

Post Mortem Changes in Meat and Their Possible Relation to Tenderness Together with Some Comparisons of Meat from Heifers, Bulls, Steers, and Diethylstilbestrol Treated Bulls and Steers / *80*

Positional Bias in Sensory Assessments / *86*

Studies on the Dehydration of Lima Beans / *91*

Effect of Temperature and Moisture on Storage Stability of Vacuum-Dried Tomato Juice Powder / *96*

Freeze Curing of Bacon / *101*

Effect of Post Mortem Chilling on the Keeping Quality of Frozen Pork / *104*

Factors Influencing the Degree of Settling in Tomato Juice / *109*

Studies on English (Persian) Walnuts, *Juglans regia*. I. Evaluation of Skin Color in Shelled Walnuts / *113*

Affairs of the Institute / *3*

Two New Scholarships Established

See page 4 V 12

Pages 61-116

February, 1956 Volume 10, Number 2

MAXIMUM FLAVOR RETENTION

with DRI-SEAL

"Hermetically Sealed" FLAVORS and ESSENTIAL OILS...

DRI-SEAL is a new process of encasing millions of Flavor globules, each in its own Micro-Capsule, thus sealing in the flavor for as long as desired.

DRI-SEAL Flavors are thus hermetically sealed from the atmosphere, which effectively prevents evaporation, oxidation, deterioration and also prevents cross blending with other ingredients.

DRI-SEAL Flavors will remain uniform in quality, strength and freshness throughout the life of your product.

Since DRI-SEAL Flavors are instantly soluble in water, the flavor is released by the consumer in its original strength at the time the product is used.

Overcoming of volatility, will effect very attractive reductions in your raw material and processing costs, since a smaller amount of flavor is required in the finished product.

Samples of DRI-SEAL Flavors and technical data applicable to your requirements will be promptly forwarded on your request.

Especially Recommended for:

Cake Mixes • Decorating Sugars • Dessert Powders • Gelatin Desserts • Icing Mixes • Ice Cream Mixes • Pastry Fillings • Soft Drink Powders • Pharmaceuticals

Manufactured by

NEUMANN-BUSLEE & WOLFE, INC.

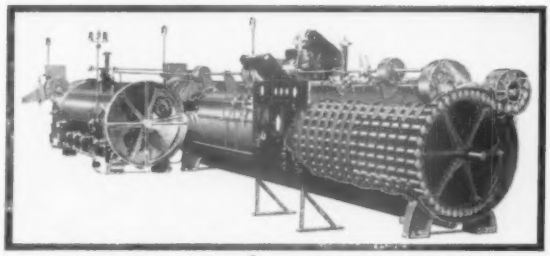
5800 NORTHWEST HIGHWAY

CHICAGO 31, ILL.

Find out WHY more and more canned foods are processed in FMC "Sterilmatic" Pressure Cookers and Coolers

HERE'S YOUR "KEY TO MODERN CANNING"

This colorful 20 page brochure describes the "Key to Modern Canning"—food processing techniques and equipment that have virtually revolutionized the canning industry. See for yourself how this famous "in-can" method of sterilization provides the precise processing control needed to maintain highest standards of product quality and uniformity. Use the handy coupon for your free copy of "The Sterilmatic Story."



"The most Advanced Food Processing Lines Available Today!"

FOOD MACHINERY
AND CHEMICAL CORPORATION
Canning Machinery Division

General Sales Offices:

WESTERN: SAN JOSE, CALIFORNIA • EASTERN: HOOPESTON, ILLINOIS

FOOD MACHINERY AND CHEMICAL CORPORATION
333 W. Julian St., San Jose 6, Calif.

Please send me a copy of your brochure "The Sterilmatic Story." 416-11

Name _____ Title _____

Company _____

Address _____

City _____ Zone _____ State _____

Your juice needs this advantage

Did you know that ascorbic acid may be added to certain fruit and vegetable juices to standardize their vitamin C content, thus overcoming wide variations which can occur *(see table below)*. Many nutritionists believe that the public interest is best served when the ascorbic acid content of processed juices is so standardized. The cost is nominal, the processing simple. A label statement of 100% of the minimum daily adult requirement for essential vitamin C may be made when a serving of juice contains 30 mg. of ascorbic acid.

Why send your juice to market with the "handicap" of inadequate nutritional value? Use Roche ascorbic acid to standardize its vitamin C content. We have helped many processors to make their good foods better and we're ready to help you. Why not investigate today?

Ascorbic Acid Content of Canned Juices

Below are examples of minimum and maximum levels of ascorbic acid in commercially canned juices. Note the wide variations! All figures are in milligrams per 100 grams of juice. Data from U. S. Department of Agriculture.

	Min.	Max.
Grapefruit juice	10.0	49.0
Orange juice	9.7	70.0
Pineapple juice	5.4	18.0
Apple juice	0.2	3.6
Grape juice	0.0	4.7
Tomato juice	2.5	32.0

Orange • Grapefruit • Lemon • Tangerine • Apple • Grape Pineapple • Cranberry • Tomato • Vegetable blends

No matter which type of processing you use—Canning • Concentrating • Freezing • Dilution in the form of "ades"—your juice will be better when its ascorbic acid content is standardized.

New low price of ascorbic acid makes juice standardization more attractive than ever.

keeping faith with nature

ROCHE
ASCORBIC ACID

VITAMIN DIVISION • **HOFFMANN-LA ROCHE INC.** • NUTLEY 10, N. J.
Pacific Coast: L. H. Butcher Company, Los Angeles, San Francisco, Seattle, Portland, Salt Lake City
In Canada: Hoffmann-La Roche, Ltd., Montreal, Que.

Affairs of the Institute

Food Field News of Public Interest
Regional News
Personnel
Phi Tau Sigma National Meeting
Annual Meeting News
Newly Elected Members
Selected Abstracts
Food Industry Topics
Future Meetings
Books

Food Field News of Public Interest

RECOMMENDATIONS OF THE GENEVA JOINT FAO/WHO CONFERENCE ON FOOD ADDITIVES

From Dr. H. C. Spencer, Chairman, IFT Committee on Chemicals in Food, comes a copy of the interesting report of the Geneva Conference on Food Additives (19-22 September, 1955). Space considerations permit only the reprinting of the recommendations section of the report but those interested in the full report should contact Dr. J. F. Mahoney, Manager, Technical Service, Merck and Co., Rahway, N. J. Dr. Mahoney was a member of the U. S. delegation to the Conference. These are the recommendations:

The Joint FAO/WHO Conference on Food Additives recommends to the Directors-General of FAO and WHO:

A. That the two Organizations

1. Collect and disseminate information regarding existing legal requirements relating to food additives in member countries and on any subsequent changes in such requirements;

2. Collect and disseminate information, by means of appropriate data sheets, on the physical, chemical, biochemical, pharmacological, toxicological and other biological properties of individual food additives with particular regard to their absorption, metabolism, excretion, acute and chronic toxicity and carcinogenic effects in animals, as well as on the methods of and reasons for their use or their limitation or prohibition;

3. Co-operate with national and international governmental and non-governmental bodies in this field, and assist, as far as is acceptable and desirable, in the co-ordination of programmes of investigation in such a way as to obtain all requisite scientific and technological information on individual food additives, while avoiding undue overlapping and duplication of effort.

B. That one or more expert committees concerned with the technical and/or administrative aspects of the problem should be convened as soon as feasible to

1. Formulate general principles governing the use of food additives, with special reference to their legal authorization, based on appropriate consideration of their harmlessness, their standards of purity, their limits of tolerance, and the social, economic, psychological and technological reasons for their use, and taking into account the work already done in this field by national and

(Continued on page 4)

FOOD TECHNOLOGY

Published Monthly by the Institute of Food Technologists

Editor

MARTIN S. PETERSON

Editorial Office: 11606 South Bell Avenue, Chicago 43, Illinois

Consulting Editor
Z. I. KERTESZ

Editor Emeritus
C. OLIN BALL

Associate Editors

C. D. ATKINS
JOHN C. AYRES
HAROLD A. CAMPBELL
LIONEL FARBER
RICHARD H. FORSYTHE
DEAN FOSTER
SAMUEL A. GOLDBLITH
C. HAMILTON KENNEY
AMIHUD KRAMER
ROBERT A. LARSEN
FRANK A. LEE
GIDEON E. LIVINGSTON
R. E. MORSE
J. ORVIN MUNDT
WILLIAM RAMAGE
WILLIAM P. RATCHFORD
F. H. REUTER
J. G. WOODROOF

ADMINISTRATIVE DATA AND DIRECTORY

Office of the Editor

11606 South Bell Avenue, Chicago 43

Address to this office all manuscripts, proofs, letters pertaining thereto, etc. Prospective contributors are invited to send for the pamphlet *Information and Suggestions to Authors* which contains style instructions.

Responsibility for statements appearing in FOOD TECHNOLOGY rests on the author thereof; points of view expressed in the columns of the journal do not necessarily have the endorsement of the Institute of Food Technologists. Mention of commercial products in the technical pages of this Journal is not to be construed as a recommendation of such products over others in the same category.

Business Manager

CHARLES S. LAWRENCE

176 West Adams Street, Chicago 3, Illinois

Address to the business office all requests for subscriptions, changes of address, and information on advertising. Claims for copies lost in the mails must be received 30 days after issue (90 days, foreign). Changes of address must be received at least two weeks before date of issue.

Subscription Rates: For members the cost of subscription is included in the annual dues. Non-members: domestic, $8.50 per year; Canada, Cuba and Mexico, $10.00 per year; all other foreign, $12.00 per year. Single and back copies: domestic, $1.00; foreign, $1.25.

Advertising Representatives: *Eastern:* Duncan Macpherson, 126 Summit Avenue, Jenkintown, Pa. *Midwestern:* Dale McCutcheon & Co., 154 E. Erie Street, Chicago 11, Illinois. *West Coast:* William A. Ayres Company, 233 Sansome Street, San Francisco 4, California.

Publication Office

The Garrard Press

119 West Park Avenue, Champaign, Illinois

Address to the Publication Office all requests for non-member subscriptions, back volumes, single copies (costs are listed above). Authors desiring reprints should address orders to this office; rates are printed on the order blank. (Requests for a single reprint of a published paper should be addressed to the author.)

FOOD TECHNOLOGY is published by the Institute of Food Technologists and printed by the Garrard Press, Champaign, Illinois, U. S. A.

Copyright, 1956, by the Institute of Food Technologists.

Mailing Permit: Entered as second-class matter, Feb. 25, 1947, at the Post Office at Champaign, Illinois, under the Act of August 24, 1912.

FOOD FIELD NEWS OF PUBLIC INTEREST

(Continued from page 3)

international bodies as well as the suggestions contained in various reports submitted to the Conference;

2. Recommend, as far as practicable, suitable uniform methods for the physical, chemical, biochemical, pharmacological, toxicological and biological examination of food additives and of any breakdown products formed from them during processing; for the pathological examination of experimental animals; and for the assessment and interpretation of the results;
3. Report on the contents and interpretation of the existing data sheets and advise on any alterations which might be desirable in their future presentation;
4. Advise on future activities of the two Organizations in the field of food additives.

C. That as regards A(1) and B(2) above, priority should be given to:

1. Food colours
2. Preservatives
   a. Antimicrobial agents
   b. Antioxidants
3. Emulsifiers

This order of priority would not exclude the subsequent consideration of other groups.

COUNCIL ON FOODS AND NUTRITION (A.M.A.) ADOPTS NEW MODE OF OPERATION

A statement explaining in general terms the new method of operation of the Council on Foods and Nutrition of the American Medical Association has been released, following the discontinuance of the seal-acceptance program.

Desirable nutrient standards for certain classes of foods are being developed by the Council. Since the physical properties of foods are subject to regulation by the Food and Drug Administration and by the laws of the individual states, the standards to be developed by the Council will be directed toward the improvement of the nutritional aspects of foods. These standards will appear in the J.A.M.A. Those for vitamin D fortified whole milk and evaporated milk appeared in the November 5, 1955 issue of the J.A.M.A.

The Council is continuing to review educational food advertising, i.e. advertising dealing with categories of food without reference to specific brands, processors or distributors. When such advertising is considered to be consistent with current authoritative medical opinion, permission will be granted to use a statement indicating this fact.

The Council is now expanding its nutrition education activities. It will gather and present factual material in the form of reports, articles and scientific exhibits. Conferences on topics of current interest in the field of nutrition, such as the symposium on inorganic elements in human nutrition which was held at Vanderbilt University in April, 1955, will be sponsored by the Council.

Thus the Council will continue to give attention to the improvement of foods, and will encourage accurate food advertising. Increased emphasis on nutrition will serve an important role in keeping the physician and the public informed on recent developments in nutrition and its importance in health and disease.

OHIO VALLEY SECTION ESTABLISHES SCHOLARSHIP

Latest addition to the rapidly growing list of scholarship opportunities for food technology students is a scholarship to be known as the Ohio Valley Section Institute of Food Technologists Scholarship. The sum of $5000 is to be invested by the donor, the Ohio Valley Section, and the income will be used to support scholarships for a deserving undergraduate student or students majoring in Food Technology. Students who have satisfactorily completed at least one quarter of work in the College of Agriculture at The Ohio State University will be eligible. Awards will be made on the basis of scholarship, participation in student activities, leadership, and need. The Director of the Institute of Nutrition and Food Technology, a representative of the Ohio Valley Section, and the Dean of the College of Agriculture or his representative will act as the scholarship committee and make recommendations for the awards to The Ohio State University Scholarship Committee.

It is anticipated that the first candidate will have been selected prior to the fall semester, 1956.

THE IFT COMMITTEE ON EDUCATION: AN INTERIM REPORT

Last year this committee was asked by the National Council to make a recommendation for a uniform curriculum for the education of food technologists. The reason for the request was the desire by some members of IFT that there be a form of accreditation for schools offering Food Technology educational programs.

The committee was not able to comply with the Council's request as there wasn't time to investigate the problem and be sure that a complete answer was obtained. This year's committee has been asked to continue investigating the possibility of a uniform curriculum. Irrespective of what we feel about the accreditation of schools teaching Food Technology, there does seem to be some merit in considering the development of a "core" curriculum in the training of food technologists. By "core" is meant the fundamental or basic science courses on which the applied field of Food Technology is built.

Before preparing such a "core" curriculum it seems advisable to come to some agreement as to:

1. The philosophy involved in the training of food technologists.

2. What type or types of people should ultimately be graduated.

Perhaps the best way for the committee to get going is for me to make a proposal on each of these two points and then we can tear down and rebuild. For the pro-

(Continued on page 6)

More Profits

through Proctor Drying Ranges

- Newest Pre-forming Techniques
- Improved Air Distribution
- Faster, More Uniform Drying
- Flexibility of Operation
- Guaranteed Product Quality

PROCTOR CONTINUOUS CONVEYOR DRYER
AT NATIONAL YEAST COMPANY

Yeast requires sensitive drying methods. This Proctor & Schwartz installation at National Yeast Company maintains the uniform quality, color, and viability of the yeast at considerably increased drying rates.

Proctor equipment provides the control and flexibility essential to profitable drying performance. Many wet-solid materials heretofore unsuited to conveyor drying can now be handled with speed and efficiency. And, as with all Proctor equipment, guarantee *is in terms of finished product produced.*

WRITE FOR BULLETIN #390

PROCTOR DRYING EQUIPMENT — WRITE FOR DETAILED INFORMATION

- Tray Dryers
- Truck Dryers
- Pre-forming Feeds
- Continuous Conveyor Systems
- Spray Dryers

Proctor

PROCTOR & SCHWARTZ, INC.

Manufacturers of Industrial Drying Equipment and Textile Machinery — Philadelphia 20, Pa.

FOOD FIELD NEWS OF PUBLIC INTEREST

(Continued from page 4)

posal on the philosophy of training food technologists, I am providing a brief account of the teaching philosophy of the Department of Food Technology here at Rutgers University. We do not believe that we have the best philosophy but it may be a starting point for this committee.

As to what type or types of food technologists should receive training, here at Rutgers we believe there are two types. There is one type that intends to do research and there is another whose abilities and inclinations are more towards production, quality control, or inspection work. The person planning for a research career will normally be preparing also for advanced degree work, while the other will usually be terminating with the Bachelor's degree. Again we do not believe that we have the best answer but it is offered for the committee's consideration.

The "core" curriculum here at Rutgers for the research person is:

1. Chemistry through physical chemistry.
2. Mathematics through calculus.
3. One year of physics.
4. One year of bacteriology.
5. One semester of engineering drawing.

The "core" curriculum for the other person is the same as for the research person with the exception that he does not take physical chemistry or calculus. Thus if he decides to go over into research training or go on for advanced degree work he needs only to pick up these two subjects.

Comments on the subject of a uniform curriculum for the education of food technologists will be welcomed.

WALTER A. MACLINN, Chairman
IFT Committee on Education

PHILOSOPHY OF TEACHING

Department of Food Technology
Rutgers University

The purpose of the Department of Food Technology is to prepare students to embark on a professional career in the field of preserving food. For the undergraduate student, two distinct curricula are provided—one designed for the student intending to pursue research work as a vocation; the other designed for the student desirous of entering the production or the quality control field. The former stresses basic principles more than does the latter. Training in the understanding of basic principles rather than in the practice of specialized procedures, it is believed, decreases the length of the indoctrination period for the newcomer in his vocation.

Food Technology, the science of preserving and manufacturing food, is based upon principles of various branches of science, foremost among which are mathematics, physics, chemistry, microbiology, and mechanical, electrical, and sanitary engineering.

The philosophy of teaching of the Department is based on two beliefs, (1) that the individual is of paramount value both in his own right and as a citizen in a democratic society and (2) that he is prepared to meet his moral and material responsibilities to himself and to society only through diligent personal effort to develop his power of understanding, his analytical skill, and his manual dexterity. To attain these ends, studies in the humanities and basic studies in several of the sciences are included in the teaching curricula. It is believed that a student in these curricula best acquires a broad development by gaining a systematized knowledge of principles, theorems and hypotheses, without cluttering his mind with little used specialized facts and procedures. The constant purpose, therefore, is to instill in the individual a powerful incentive to search for and to apply true principles in all aspects of human relations.

To develop his aptitude in craftsmanship, the student is required to do laboratory work in physics, chemistry, and bacteriology and is encouraged to do similar work in a branch of engineering. This policy presupposes that manual skill is not selective, in other words, that aptitude in the use of the hands in one field extends into other fields. It also presupposes that the cultivation of this aptitude in a basic line of endeavor constitutes better vocational training than the cultivation of such aptitude in routine courses covering specialized Food Technology procedures. In addition to the manual proficiency acquired in such work, a knowledge of principles gained in laboratory work in physics, chemistry, microbiology, or engineering is certain to be useful in any vocation in the field of Food Technology.

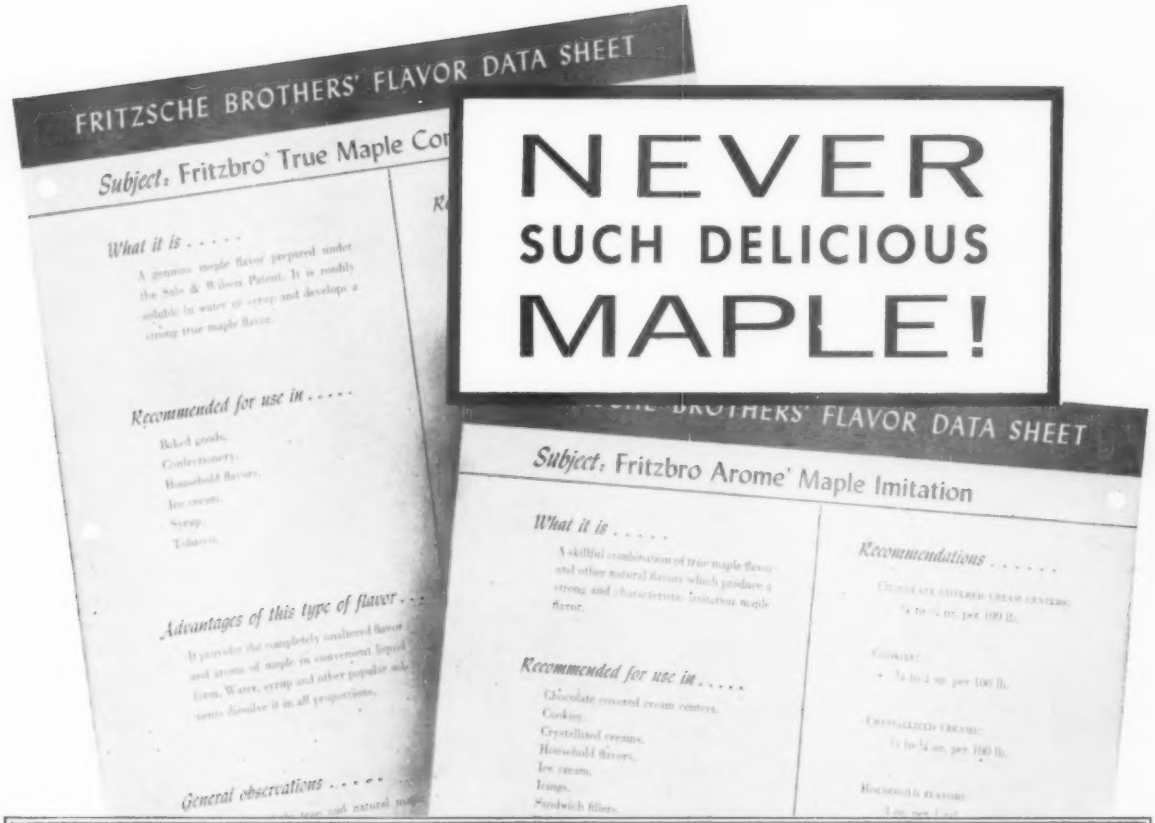
Notwithstanding the heavy stressing of basic training, the acquiring of factual knowledge is not neglected. The historical background of Food Technology and specialized knowledge dealing with the more complex applications of science in Food Technology are taught in courses.

Facts are also acquired by the student through research. The research work is concerned with problems in food preservation and manufacture and to food packaging insofar as it contributes to food preservation and manufacture. Research constitutes a substantial portion of graduate level training.

Much practice in written expression is required of the students to express (a) what has been learned, (b) plans for activities, including research, and (c) reports on activities of the student, on literature reviews, etc. It is believed that the expression of thoughts in written form leads to clear thinking and to an understanding of the subject matter being covered.

The ability to understand, analyze, and interpret facts and principles (the goal of every realistic educational curriculum) is a difficult goal to attain. Thus, the essence of obtaining an education is hard work. With a preponderance of basic science courses in the curriculum, selectivity for entrance is essential. Successful results can be expected only if those who matriculate for training in Food Technology are persons who are strongly motivated by a desire for an education.

(Continued on page 8)


FRITZSCHE BROTHERS' FLAVOR DATA SHEET
Subject: Fritzbro' True Maple Co
What it is . . . . .
Recommended for use in . . . . .
Advantages of this type of flavor . . .
General observations . . . . .
NEVER
SUCH DELICIOUS
MAPLE!
FLAVOR DATA SHEET
Subject: Fritzbro Arome' Maple Imitation
What it is . . . . .
Recommended for use in . . . . .
Chocolate covered cream centers.
Cookies.
Crystallized creams.
Household flavors.
Ice cream.
Icings.
Sandwich fillers.
Recommendations . . . . . .

WHETHER GENUINE OR IMITATION, you have your choice of two of the finest maple flavors ever offered, in

FRITZBRO® TRUE MAPLE CONCENTRATE

a genuine maple flavor prepared under the Sale & Wilson Patent which provides the natural, unaltered flavor and aroma of maple in convenient liquid form; and:

FRITZBRO AROME® MAPLE IMITATION

a skillful combination of true maple flavor and other natural flavors to produce a strong characteristic imitation maple effect. These specialties may be used wherever the need is for fine, smooth maple effects and where solubility, convenience, economy and ease of handling are matters of important consideration. These flavors are recommended for use in confectionery manufacture, baked goods, household flavors, ice creams, syrups and tobaccos. For free Flavor Data Sheets describing these materials and/or working samples, write us on your letterhead indicating the use to which requested sample will be put.

FRITZSCHE *Established* 1871

Brothers, Inc.

PORT AUTHORITY BUILDING, 76 NINTH AVENUE, NEW YORK 11, N. Y.

BRANCH OFFICES *and* †STOCKS: *Atlanta, Georgia, Boston, Massachusetts,* †*Chicago, Illinois, Cincinnati, Ohio,* †*Los Angeles, California, Philadelphia, Pennsylvania, San Francisco, California, St. Louis, Missouri, Montreal and* †*Toronto, Canada and* *Mexico, D. F. FACTORY: *Clifton, N. J.*

FOOD FIELD NEWS OF PUBLIC INTEREST

(Continued from page 6)

CHEMICALS IN FOODS LEGISLATION

Some well qualified observers have reported that since 1956 is a national election year, it is more rather than less likely that food additives bills will be considered by the 2nd Session of the 84th Congress. The subject is nonpolitical and for the protection of public health. To be the sponsor of a bill which will satisfactorily compromise the debatable issue is the goal of several Congressmen.

Besides the scientific and technological aspects of the problem, the bills incorporate different opinions on the regulatory process to be employed by the Food and Drug Administration. Pre-testing of new food additives has general agreement. Prior approval or "licensing" by F.D.A. and the use of court injunctions after certification of safety of the chemical by manufacturers or users have been proposed.

There is some agreement on the desirability of separation of the consideration of unintentional chemicals in foods from deliberate functional food additives. This may leave unintentional chemical additives as the only class of chemicals under Section 406(a) of the Food Drug and Cosmetic Law.

Opinion is still divided on the subject of scientific advisory committees although a shift of sentiment in favor of such committees has been noted since the successful use of such a Committee by the Secretary in the Aramite pesticide tolerance case.

Inasmuch as public hearings may be held early this year, plans should be made promptly by those expecting to take part in the molding of opinion leading to new food legislation.

It is expected that pertinent information on the more important Bills and Amendments will appear in this column from time to time.

COMMITTEE ON CHEMICALS IN FOODS

Phi Tau Sigma National Meeting Held in Boston

New Officers Installed: Dr. Livingston Sets Goals

Boston, December 1, 1955: Phi Tau Sigma, the national honorary food science society, held its first annual business meeting here today. The meeting was highlighted by the installation of the national officers for 1956. They are: Dr. William B. Esselen of the University of Massachusetts, president; Dr. Carl S. Pederson of Cornell University, vice-president; and Dr. Jean Caul of the Arthur D. Little Co., secretary-treasurer. These posts had been held during 1955 by Dr. Gideon E. Livingston of the University of Massachusetts, Dr. William D. Powrie of the Canadian Central Experimental Farm, and Dr. Enio Feliciotti of the Hazel Atlas Co., respectively.

Noting that this day marked the second anniversary of the establishment of Phi Tau Sigma, retiring president Dr. Gideon E. Livingston warned that the society faced the most crucial years of its existence. If it is to weather them, he admonished, it must strive to become "not only a fraternity of food scientists, but an instrument for the advancement of food science itself."

Retiring president, Dr. G. E. Livingston (2nd left), congratulating 1956 Phi Tau Sigma president, Dr. W. B. Esselen, also of the University of Massachusetts. Others are Dr. F. J. Francis (left), executive secretary and Dr. Jean Caul, secretary-treasurer. Absent is new vice-president, Dr. Carl S. Pederson of Cornell University.

Stating that its mere ability to grant recognition to scientific achievement would not justify the existence of the society, Dr. Livingston outlined five areas of endeavor which might be developed in the future: 1. fostering the concept of food science as a broad field drawing from all segments of science in any way concerned with the nature, production or utilization of food; 2. exercising its responsibility in food science education by concerning itself with standards of training and disseminating information on matters of educational interest; 3. developing its publications, currently limited to a quarterly, *The Food Scientist*, which will publish primarily biographical, historical, educational and review articles—by sponsoring the publication of monographs; 4. sponsoring various awards, recognizing scholastic, research or teaching achievement, and 5. granting financial assistance toward fundamental research in food science.

Dr. Olin Ball has accepted the post of editor of *The Food Scientist*. His knowledge of the major problems of food research and technology and his distinguished contributions to these fields assures a bright future for the journal.

Annual Meeting Bulletin Board

FINAL NOTICE ON SCHEDULING ANNUAL MEETING BREAKFASTS AND LUNCHEONS

Requests for special breakfasts and luncheons, together with estimated attendance should be sent immediately to Mr. W. O. Edmonds, 624 Norton Ave., Kirkwood 22, Missouri. Closing date for requests is February 15, 1956.

Tentative open dates are:

Breakfasts—June 11-12-13-14 (Monday through Thursday).

Luncheons—Tuesday, June 12; Thursday, June 14.

IMITATION RASPBERRY BY FIRMENICH

You get the direct and authentic reproduction of raspberries in their full perfection in Raspberry Flavor by Firmenich. For Firmenich took fully ripe raspberries, freshly severed from the stem, captured their delicate and fugitive flavor, and by original research reconstructed it with all its significant and desirable components. Firmenich Raspberry comes to you as a precise and potent flavor material of the utmost purity and stability to enhance the flavor of your products and to give them greater sales appeal. Samples and technical data on request.

FIRMENICH & CIE
SUCCESSEURS DE
CHUIT, NAEF & CIE.
GENEVE SUISSE

FIRMENICH INCORPORATED

Program Complete for Symposium on Food Physics

The program on the role of the physicist in improving the quality and processing of foods, subject of the symposium to be held in San Antonio, March 15-16, 1956, at the Plaza Hotel has been completed. The symposium is sponsored jointly by Southwest Research Institute and the Institute of Food Technologists. Speakers will be leaders in the development of new techniques for food processing. Key research people from the food industries throughout the nation will attend.

Great changes in food packaging and processing in the past few years foreshadow even more momentous developments to come. Demands of homemakers for more fully processed foods and a wider variety have completely changed food processing methods. Food processors are using new techniques which allow them to achieve much better products than our grandmothers could ever imagine. Every variable can be controlled through electronic scanning and measurement devices. Meats can be smoked uniformly through the use of an electrostatic charge so that smoking time is no longer a matter of chance and guesswork.

Scientists today are working on the irradiation of foods for sterilization and preservation. This technique promises to greatly lengthen the shelf-life of certain foods without affecting taste, color or odor.

There are ovens on the market which will cook foods with radio frequency or dielectric heat. Since heat is merely a matter of molecular activity, the motion of the molecules in a food can be accelerated with radio frequency waves and will cook evenly throughout. One drawback to dielectric cooking is the necessity for using a separate source of radiant heat in order to produce the attractive brown crust, color, and some of the taste factors we are accustomed to.

Physicists are constantly seeking ways to utilize other forms of energy in the processing and preparation of food. The use of ultrasonics offers some possibilities because this too may eventually enable us to accelerate the motion of the molecules efficiently. Sonics are also proving useful in the production of more perfect mixes and emulsions of food.

Quality control lends itself very readily to the application of physical sciences techniques since quality is largely a measure of the physical characteristics of a product.

A uniform high degree of quality will not mean that foods become less interesting and tasteful. Variations can always be made by the homemaker in seasoning, temperature, time, and humidity controls.

When today's housewife buys food, she also buys prefabricated, built-in maid service which includes cleaning, peeling, cutting up, measuring and mixing. It includes extra time saved in precooking and portioning. The result of this is superior freshness, uniformity of results, a higher degree of nutrition, better retention of vitamins, minerals and other nutrients, as well as better flavor and convenience in storing and serving.

These added values increase the cost of foods, but they save three-fourths of the time formerly required to prepare dinner from scratch in the kitchen.

The revolution going on in food production, selection, processing, packaging, distribution and preparation of foods is still in the early stages and should lead to undreamed-of improvements in the future feeding of this nation and the rest of the world.

Here is the detailed program:

THURSDAY, MARCH 15

8:00 A.M. Registration, Plaza Hotel

9:00 A.M. *Welcome*
H. Vagtborg, President, Southwest Research Institute; L. E. Clifcorn, President, Institute of Food Technologists.

9:15 A.M. "40 Fields of Physics: Their Importance to the Food Industry"
P. M. Erlandson, Director of Physics Research, Continental Can Co., Chicago, Illinois.

10:00 A.M. "Rapid, Non-Destructive Analysis of Liquids and Solids by Magnetic Resonance Absorption"
T. M. Shaw, Senior Research Physicist, Southwest Research Institute, San Antonio, Texas.

10:45 A.M. "Vapor Phase Chromatography A New Method for the Separation and Identification of Volatile Materials in foods"
K. P. Dimick, Chemist, and J. Corse, Chemist, Western Utilization Research Branch, U. S. Department of Agriculture, Albany, California.

1:30 P.M. "Applications of Physics in the Meat Industry"
D. M. Doty, Assistant Director Research and Education, American Meat Institute Foundation, Chicago, Illinois.

2:15 P.M. "Measurement of Crystallization in Foods"
A. Cornwell Shuman, Assoc. Professor of Food Chemistry, Purdue University, Lafayette, Indiana.

3:00 P.M. "Application of Physics to Studies of Breadmaking Quality of Wheat"
I. Hlynka, Chemist, Grain Research Laboratory, Winnipeg, Manitoba, Canada.

3:45 P.M. "Measurement of Quality in Food and Agricultural Commodities by Physical Methods"
K. H. Norris, Agricultural Engineer, Marketing Research Division, USDA, Beltsville, Maryland.

7:30 P.M. Banquet, Plaza Hotel

8:30 P.M. Address (Topic and speaker to be announced)

FRIDAY, MARCH 16

9:00 A.M. "Food Processing with Ultrasonics"
Quentin C. McKenna, Research Physicist, Hughes Aircraft Co., Culver City, California (Formerly President, McKenna Labs, Inc.).

9:45 A.M. "The Potential Role of Nuclear Reactors in Food Processing"
R. J. Beeley, Senior Engineer, Atomics International, a Division of North American Aviation, Inc., Canoga Park, California.

10:30 A.M. "Effect of New Instrumentation on Modern Chemical Plant Operation. Can Recent Developments in Instrumentation and Automatic Control Solve Important Problems in the Food Industry?"
V. E. Hanson, Assistant Director, Engineering Research Laboratory, Experimental Station, E. I. duPont de Nemours & Co., Wilmington, Delaware.

(Continued on page 12)

YEAR AFTER YEAR

IT'S Alvamaple

For real "True-To-The-Tree" Goodness!

In many food plants ALVA imitation maple has been the standard for over thirty years as flavoring for candies, syrups, baked goods, extracts, ice cream, etc.

Wherever the best real North Woods flavor is wanted, try ALVA imitation maple. We think it will be your standard too, year after year.

Samples and recommendations for your particular product at your request.

van Ameringen-Haebler, Inc.
521 West 57th St., New York 19, N. Y.

PROGRAM COMPLETE FOR SYMPOSIUMS ON FOOD PHYSICS

(Continued from page 10)

11:15 A.M. "Round-table Discussion"
All speakers participating.

11:45 A.M. Concluding Remarks
J. P. O'Meara, Manager, Chemical Physics, Southwest Research Institute.

1:00 P.M. Barbecue Luncheon
Southwest Research Institute Grounds.

2:00 P.M. Tour of Southwest Research Institute

3:00 P.M. Adjournment

Fellowship Honoring Samuel Cate Prescott Announced by the Refrigeration Research Foundation, Inc.

The Refrigeration Research Foundation, Inc., has established a graduate fellowship with a stipend of $2500 for one year which shall be used to pay academic expenses, such as tuition and/or incidental expenses of a graduate student in the field of food refrigeration or food technology, with special reference to the application of refrigeration to foods. The Fellowship is established in honor of the Foundation's Chairman of the Board of Governors, Dr. Samuel Cate Prescott, Emeritus Dean of Science, Massachusetts Institute of Technology. Designed to give encouragement to young men and women in research in the fields of food refrigeration and refrigerated warehousing of commodities, it is also designed to point up opportunities for research or employment which exist in these spheres of work.

It is especially recommended by the Award Committee administering the Fellowship that the applicant already have a Bachelor of Science Degree or its equivalent, and that the award be used in giving such a student help in attaining a graduate degree in the field specified. His previous training should include work in the fields of biology, bacteriology and the essential branches of chemistry and physics, including some knowledge of the principles of heat transfer and thermodynamics as applied in the application of refrigeration.

While it is the intention of the Refrigeration Research Foundation to continue this program from year to year, beginning with the academic year 1956-57, it reserves the right to terminate support of this Fellowship on due notice.

It is assumed that during the academic fellowship year, the work required should include such courses as may ordinarily be required for the Master of Science Degree in the institution attended, and should further include some course or investigation work in the field of refrigeration of foods, or for work towards a higher degree, if the candidate already has a Master's degree.

The Foundation reserves the right to withhold the Fellowship Award in any year in which an acceptable candidate cannot be selected.

Address applications to: Mr. H. C. Diehl, Secretary and Director, The Refrigeration Research Foundation, 200 Midland Bldg., Colorado Springs, Colorado.

Recently Elected Members of IFT

Raymond T. F. Aea
812 Mapunapuna Street
Honolulu, T. H.

Emil L. Bernier
Continental Can Co., Inc.
200 Berkeley St.
Boston, Mass.

William E. Delaney
7331 Maryland Ave.
Chicago 19, Ill.

Dr. Robert A. Gillies
Univ. of Illinois
Dept. of Food Tech.
Urbana, Ill.

Elwynn L. Keyser
J. H. Filbert Inc.
3701 S. Western Blvd.
Baltimore 29, Md.

Rose Krog
Purdue University
School of Home Econ.
Lafayette, Ind.

Robert L. LaBelle
N. Y. S. Agr. Expt. Sta.
Geneva, N. Y.

Carl W. Lorentzen
26-46 202 Street
Bayside, L. I., N. Y.

Arthur L. Marshall
6 Lakeside Avenue
Beverly, Mass.

Scott McLeod
Columbia River Packers Ass'n, Inc.
P. O. Box 60
Astoria, Ore.

Joseph T. Rossi
Fruit Industries, Inc.
P. O. Box 338
Bradenton, Fla.

Lloyd B. Rothe
Kelco Co.
120 Broadway
New York 5, N. Y.

George Rubin
650 Adee Avenue
New York 67, N. Y.

Frederick Saporito
809 Barbara Blvd.
Franklin Sq., N. Y.

Peter J. Stavish
1112 Geil Ave.
Des Moines 15, Ia.

Dr. V. C. Stebnitz
Chgo. Dairy & Food Labs.
6930 N. Clark St.
Chicago 26, Ill.

Margaret W. Stroud
Syracuse University
College of Home Econ.
Syracuse 10, N. Y.

Alex Vanderborg
851 Hunts Pt. Ave.
Bronx 59, N. Y.

Johan van Manneren
Central Inst. for Nutrition Res. T. N. O.
Fisheries Dept.
Haringkade 1, Ijmuiden
The Netherlands

Dr. N. Viswanadham
Univ. of Technology Hostel
Kensington, N.S.W.
Australia

Marcus Vogel
The Griffith Labs., Inc.
4900 Gifford Ave.
Los Angeles 58, Calif.

Heinrich Zuegg
2224 Piedmont Ave.
Berkeley 4, Calif.

STUDENTS

Max F. Bocklet
Virginia Polytechnic Inst.
Dept. of Horticulture
Blacksburg, Va.

Joyce A. Ferguson
Rm. 225 Sackett B
Corvallis, Oregon

Kenneth W. Hamilton, Jr.
664 Catterlin Ave.
Salem, Ore.

Frank G. Herget
5626 Merrick-C
Coral Gables, Univ. Br. 46, Fla.

Phillip Issenberg
11 Sparhawk Street
Brighton 35, Mass.

Robert J. Larwood
2111 Harrison
Corvallis, Ore.

Jack R. Matches
440 No. 6th Street
Corvallis, Ore.

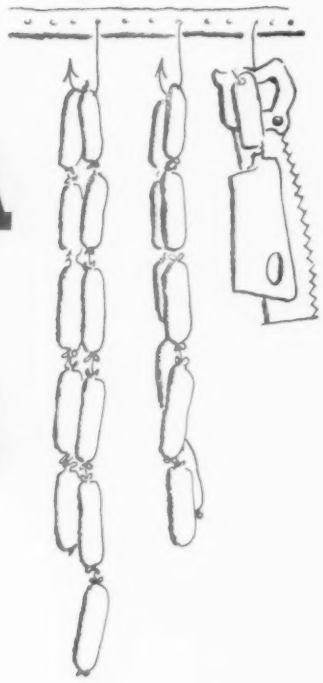
Birgit Mounberg
The Univ. of Wisconsin
Babcock Hall
Madison 6, Wis.

John J. O'Neil
99 High Street
Malden 48, Mass.

Stanley H. Shimabuku
310 So. 15th St.
Corvallis, Ore.

Harry L. Wornath
Box 315A, Route 1
Lake Grove, Ore.

SPISORAMA SOLUBLE STRAIGHTS



Spell Sure Success for your meat products! Spisorama Soluble Straights are *completely pure products*, and both strength and quality are uniform from batch to batch. Let the D&O Laboratories become your personal sentinel on quality control. If you use

Pepper · Ginger · Coriander · Cardamom
Allspice · Mace · Sage

in your prepared meat or other food product ... try Spisorama Soluble Straights. We sincerely invite your most exacting comparisons.

Essentially for you

D&O ESTABLISHED 1798

OUR 157th YEAR OF SERVICE

DODGE & OLCOTT, INC.

180 Varick Street, New York 14, N. Y.

Sales Offices in Principal Cities

ESSENTIAL OILS • AROMATIC CHEMICALS • PERFUME BASES • FLAVOR BASES • DRY SOLUBLE SEASONINGS

*ACRONIZED is a trade-mark of American Cyanamid Company

poultry...

news is

NOW, AT LAST, you can deliver "fresh-killed" flavor and quality right into the consumer's home!

For today, pre-packaging of poultry has become a reality with *Acronized*—the amazing new process that retards the growth of spoilage bacteria and prolongs freshness under conditions never before possible.

Acronized is the first Government-accepted process to bring you the food preserving benefits of American Cyanamid Company's antibiotic *chlortetracycline* . . . and is backed by years of research and testing.

It makes pre-packaging possible by ending the usual "incubator effect", and preserves freshness without changing the poultry's color, odor or taste.

In addition, Acronized gives you these marketing advantages:

- Protects you against delays in transit
- Opens new and more distant markets
- Reduces frequency of delivery
- Increases volume to present accounts, who can now safely carry full inventories
- Levels out peaks and valleys in your production

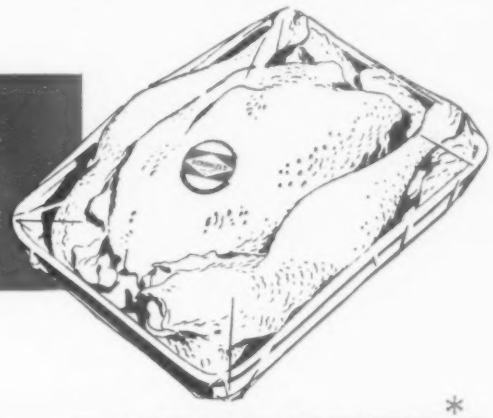
Yet Acronized requires virtually no change in your processing routine! You simply add Acronized solution to your chill tanks, and bacterial growth on the birds is retarded from that point on.

NATIONAL PUBLICITY is telling America's housewives about Acronized chicken. Now is the time to identify your poultry with this history-making advance.

Write today for details on how your plant may qualify for the Acronized franchise.

AMERICAN *Cyanamid* COMPANY Fine Chemicals Division
30 Rockefeller Plaza, New York 20, N.Y.

pre-packaging



the freshest poultry is ACRONIZED!*

Selected Abstracts*

ANALYTICAL METHODS

Partition chromatography of synthetic detergents.

FRANKS, F. *Nature, 176,* 693-4 (1955).

A convenient method of sepg. substances contg. alkyl groups differing in length was developed by means of paper partition chromatography.

The qualitative analysis of surface-active agents.

REID, V. W., ALSTON, T., AND YOUNG, B. W. *Analyst, 80,* 682-9 (1955).

A simple qual. scheme was developed for the characterization of surface-active agents. It is more positive than previous schemes. Present methods depend upon the application of a large no. of chem. tests, and this work shows how the no. of such tests may be greatly reduced by the u. v. spectroscopic examn. of the products.

Electrophoresis in agar plates.

BUSSARD, A., AND PERRIN, D. *J. Lab. Clin. Med., 46,* 689-701 (1955).

A study of the phys. conditions during electrophoresis in agar, as compared to paper, was undertaken. The almost negligible resistance offered by agar to the movement of most proteins was confirmed. The absence of trailing of proteins was noted. Detection and detn. of the amt. of proteins can be performed by direct staining of the plates and subsequent photometric scanning. With these improvements the agar plat technic permits the measurement of mobilities of charged constituents.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

Collagen and elastin in connective tissue.

HALL, D. A., KEECH, M. K., REED, R., SAXL, H., TUNBRIDGE, R. E., AND WOOD, M. *J. Gerontol., 10,* 388-99 (1955).

The *in vitro* synthesis of elastin-like material from collagen is used as a basis for the elaboration of two hypothetical schemes for the *in vivo* synthesis of elastin. The two hypotheses differ in that one supports the direct synthesis of elastin from the products of fibroblastic activity, whereas the other requires the prior formation and subsequent degradation of collagen fibrils and the synthesis of elastin from a selection of the fragments. On the basis of these hypotheses rational explanations of the histologic, electronmicroscope, x-ray, and biochem. findings on normal connective tissue can be made and the specific features of arteriosclerotic tissue, senile elastosis skin, and Ehlers-Danlos skin can be explained.

The terminal amino acids of wheat gliadin.

RAMACHANDRAN, L. K., AND MCCONNELL, W. B. *Can. J. of Chemistry, 33,* 1463-6 (1955).

Wheat gliadin was found by 2 different methods to contain 3 N-terminal histidine residues for each mol. wt. of 27,000. Trace amts. of N-terminal aspartic acid, glutamic acid, alanine, valine, and serine were also detected.

Biosynthesis of proteins. III. Precursors in the synthesis of casein and β-lactoglobulin.

ASKONAS, B. A., CAMPBELL, P. N., GODIN, C., AND WARK, T. S. *Biochem. J., 61,* 105-15 (1955).

Methods were developed for the isolation of peptides from partial acid hydrolyzates of β-lactoglobulin. The results indicate that casein and β-lactoglobulin are synthesized from the free amino acids of the blood and that peptides for milk protein synthesis are not supplied by partial hydrolysis of plasma protein.

Studies of the nitrogen sparing action of carbohydrate with the isolated perfused rat liver.

MILLER, L. L., BURKE, W. T., AND HAFT, D. E. *Federation Proc., 14,* 707-16 (1955).

The isolated perfused rat liver was used along with lysine-6-C^{13} to demonstrate that the major portion of endogenous urea N is derivable from catabolism of the blood and liver proteins. On the basis of N "balance" calcns., glucose is definitely superior to fructose in sparing the N of an added complete amino acid mixt. However, both sugars depress endogenous production to an equal extent. Supplements of lactate, pyruvate, and α-ketoglutarate are relatively inefficient in sparing the N of an added complete amino acid mixt.

BOTANY

The sweet herb of Paraguay.

FLETCHER, H. G. *Chemurgic Digest, 14,* 7 (1955).

From the leaves of this small wild shrub, gathered at time of flowering during the Paraguayan summer, chemists have extracted Stevioside, a white compound 300 times as sweet as table sugar and without apparent toxic effects in various exptl. animals. It is composed only of C, H and O and contains, as part of a large mol., three mols. of glucose. Stevioside, therefore, is not only the sweetest natural product yet found but the only substance of high sweetening power which is non-nitrogenous and contains glucose.

MICROBIOLOGY

Transfer of antigens by phage lysates with particular reference to the 1,w antigens of Salmonella.

EDWARDS, P. R., DAVIS, B. R., AND CHERRY, W. B. *J. Bacteriol., 70,* 279-84 (1955).

Through the action of phage lysates, antigens were transferred to or from 8 of

* These Selected Abstracts are made available to FOOD TECHNOLOGY through the cooperation of Associate Editor H. A. Campbell and the General Foods Corporation of White Plains, New York. The abbreviations found in these abstracts are similar to those used by Chemical Abstracts.

But why MEN over 45?

Our doctors still don't know *why*, but if you are a man over 45 you are six times as likely to develop lung cancer as a man of your age twenty years ago. They *do* know, however, that their chances of saving your life could be about *ten times* greater if they could only detect cancer long before you yourself notice any symptom. (Only 1 in every 20 lung cancers is being cured today, largely because most cases progress too far before detected.)

That's why we urge that you make a habit of having your chest X-rayed every six months, no matter how well you may *feel*. The alarming increase of lung cancer in men over 45 more than justifies such precautions. Far too many men die *needlessly!*

Our new film "The Warning Shadow" will tell you what every man should know about lung cancer. To find where and when you can see this film, and to get life-saving facts about other forms of cancer, phone the American Cancer Society office nearest you or simply write to "Cancer" in care of your local Post Office.

American Cancer Society

the *Salmonella* serotypes known to contain l, w phases. It was found that two genetically different forms of l, w antigen were present in *Salmonellae*, one of which functioned as phase 1 and the other as phase 2. The probable role of phages in the production of the new serotypes in nature was discussed briefly.

The effect of Salmonella pullorum infection on amino acids of the chick.

Ross, R. T., Holtman, D. F., and Gilfillan, R. F. *J. Bacteriol., 70,* 272-5 (1955).

Chromatographic analyses of blood and liver of chicks infected with *Salmonella pullorum* show that, during the course of infection, the levels of arginine, methionine, glycine, and tryptophan are reduced. Chicks inoculated with an avirulent strain of *S. pullorum* presented the same chromatographic pictures as normal controls. Since the organism appears to have no specific need for all four amino acids, it is suggested that the host may be utilizing them in its defense against the pathogen.

Technic for microscopic count of microorganisms directly on membrane filters.

Ehrlich, R. *J. Bacteriol., 70,* 265-8 (1955).

A technic is described for the quant. detection of microorganisms in liquid media. The liquid is filtered through a membrane filter leaving the bacteria upon the filter where they are stained. The stained cells are counted directly on the membrane filter with the aid of a light microscope.

Significance of enteric bacilli in foods.

Dack, G. M. *Am. J. Public Health, 45,* 1151-5 (1955).

Health officers face a perplexing problem at the moment whether or not to establish standards of acceptability for products like orange juice that may be based on those for carbonated beverages, milk or water. An over-all view of the health official's dilemma is presented here, together with some suggestions.

The effect of dihydrostreptomycin on the formation of adaptive enzymes by a strain of Escherichia coli.

Roote, S. M., and Polglase, W. J. *Can. J. Biochem. & Physiol., 33,* 792-6 (1955).

The adaptive formation of enzymes for the oxidation of L-arabinose, lactose and D-glucuronic acid was inhibited by dihydrostreptomycin in a strain of *Escherichia coli* which would not grow in the presence of this antibiotic. Adaptive enzyme formation was not inhibited in *E. coli* variants which would grow in the presence of dihydrostreptomycin or which required the antibiotic for growth.

The fine structure of cells.

Porter, K. R. *Federation Proc., 14,* 673-82 (1955).

An attempt was made to show that certain submicroscopic components and patterns of structure repeat from cell to cell and organism to organism at levels

RECIPE

FOR AN INSTANT DIETETIC PUDDING
LOW IN CALORIES,
IT LOOKS GOOD, TASTES BETTER, SELLS BEST!

INSTANT DIETETIC
CHOCOLATE PUDDING

Dietetic pudding mix for preparing instant-type puddings easily made with MARGEL, specially prepared algin stabilizer for low calorie cold milk puddings.

MARGEL	18.3%
FINE QUALITY DUTCH COCOA	55.2
CALCIUM GLUCONATE USP	12.8
TETRASODIUM PYROPHOSPHATE, ANHYD.	7.4
SALT	3.6
VANILLIN	0.7
SODIUM SUCARYL	1.5
SACCHARIN	0.5
	100.0%

DIRECTIONS: Add a one ounce package of the above pudding mix to two cups of milk with stirring.

CALORIC VALUE:

Caloric value of MARGEL is about 1.0 calories per gram. Pudding made with this mix and 2 cups of skim milk will provide 4 servings at 59 calories each or 6 servings at 39 calories each. Algin stabilizers reduce or replace starch and sugars, cut calorie content way down!

CHECK

these ALGIN ADVANTAGES in your dietetic syrups, salad dressings and desserts:

1) Gives desired viscosity and body.
2) Assures greater stability to emulsions.
3) Prevents separation.
4) Provides a smoother, cleaner emulsion.
5) Easy, quick, and complete solubility.
6) Easy to use in all kinds of dry mixes, dry blends, or paste type products.

For further information on the use of Kelco Algin products in dietetic food formulations, write your nearest Kelco regional office listed below.

120 Broadway, New York 5, N. Y.
20 N. Wacker Drive, Chicago 6, Ill.
530 W. Sixth Street, Los Angeles 14, Calif.
Cable Address: Kelcoalgin—New York

KELCO COMPANY

KELCO REFINED ALGIN PRODUCTS

COPYRIGHT 1955

SELECTED ABSTRACTS

of resolution provided by the electron microscope. *Cilia* and *mitochondria* in their fine structure are excellent examples. Further cell components of some special interest in this regard are a finely-divided, vacuolar system of the cytoplasm and a frequently associated small particulate.

NUTRITION

Phytic acid and its importance in human nutrition.

HARRIS, R. S. *Nutrition Revs., 13,* 257-9 (1955).

It is clear that phytic acid is present in many of our foods and that it may interfere with mineral nutrition. The phytate problem may be serious in areas of the world where the people consume large amts. of unrefined cereals and small amts. of Ca. It is not an important problem in the United States where the people usually consume refined cereals, and generous amts. of Ca-rich foods.

A study of the interrelationships of the energy-yielding nutrients, blood glucose levels, and subjective appetite in man.

FRYER, J. H., MOORE, N. S., WILLIAMS, H. H., AND YOUNG, C. M. *Metabolism, Clin. and Exptl., 4,* 459 (1955).

Protein is more important than either fat or carbohydrate in satisfying appetite, this effect of protein is unrelated to any influence on blood glucose levels or rate of glucose utilization. The low-carbohydrate diet, which had the highest satiety value, also was associated with the amt. of peripheral glucose utilization as judged from peripheral arteriovenous differences.

Body composition in obesity.

Nutrition Revs., 13, 285-6 (1955).

These studies provide objective evidence for the fact that the major body component which increases in obesity is fat. It would further seem to indicate that an organism produces only a definite amt. of protein. The amount of protein produced in the adult animal is not changed, regardless of marked increases in body weight.

The energy expenditure and food intake of individual men.

EDHOLM, O. G., FLETCHER, J. G., WIDDOWSON, E. M., AND MCCANCE, R. A. *Brit. J. Nutrition, 9,* 286-300 (1955).

Individual expenditures of energy in a group of 12 young British soldiers were detd. by collecting expired air in Douglas bags on the Max Planck Institute calorimeter. This air was then analyzed using the Haldane on the Scholander app. The energy expended for various activities in cal./min. was found to be as follows: lying—1.48, sitting—1.60, standing—1.82, marching—6.03, running—11.67, stair climbing—10.30, dressing—4.00, tennis—7.13, cycling—7.72, and driving—3.38.

Preliminary studies on the effect of feeding sorbic acid upon the growth, reproduction, and cellular metabolism of albino rats.

DEMAREE, G. E., SJOGREN, D. W., MCCASHLAND, B. W., AND COSGROVE, F. P. *J. Am. Phar. Assoc., 44,* 619-21 (1955).

Simple observations on the amts. of food eaten daily indicate that the incorporation of 10% sorbic acid into the diet did not appreciably alter the quantity of food consumed by the test animals. Some of the test animals showed a higher growth rate and a higher ratio of liver wt. to body wt. than did the controls. The reproductive capacity was found to be normal. No significant differences were observed in the oxygen consumption of liver homogenates of the parent generation; the differences observed in the first generation were significant at the 95% level. The female controls of this group showed the highest rate of oxygen consumption. The rate of oxygen consumption of the liver homogenates from the males and females of this generation treated with 10% sorbic acid were almost identical.

Relative effectiveness of antibiotics in rats given limiting B vitamins by mouth or by injection.

JONES, J. D., AND BAUMAN, C. A. *J. Nutrition, 57,* 61-71 (1955).

Limiting amts. of thiamine, riboflavin, and pantothenic acid were administered to rats either by inclusion in the diet or by subcutaneous infection, and the effectiveness of dietary antibiotics on growth detd. The results suggest that the antibiotics stimulate an increased intestinal synthesis of these vitamins, but leave the question open whether this is the only mechanism involved.

Vitamin A stability in feeds.

Nutrition Revs., 13, 270-1 (1955).

These studies demonstrate the detrimental effect of trace minerals on vitamin A stability and also show the superiority of the wax-coated, or "stabilized," vitamin A under these conditions. The stability of the vitamin A in the wax-coated product suggests its usefulness in lab. expts. in which trace mineral mixts. are used in purified or synthetic diets.

Vitamin D and calcium absorption.

Nutrition Revs., 13, 271-2 (1955).

The authors conclude that the primary effect of vitamin D is on the absorption of Ca from the intestine.

Nutritive quality of cereal proteins.

Nutrition Revs., 13, 272-5 (1955).

At the present time the vast surpluses of cereal grains in this country suggest that there is no immediate need for further production for home consumption, although numerous other countries are in a much less favorable position. However, regardless of the extent of production, there is always the continuing problem to use what is produced most efficiently in order to obtain better standards of nutriture among the consumers. Good examples of the potentialities in this regard are contained in the above investigation on the nutritive value of rice germ and in the efforts to improve the keeping properties of parboiled rice.

Relation of dietary fat level to fatty livers in several strains of mice.

FENTON, P. F., DOWLING, M. T., AND MERSHON, J. S. *J. Nat. Cancer Inst., 15,* 429-32 (1954); *Biol. Abstr., 29,* No. 23450 (1955).

Mice of strains, A, C3H, C57BL and YBR/Ch, rendered obese by feeding 50% fat diets, developed fatty livers. This was not due to a lowering of liver choline oxidase levels nor to a deficiency in choline. Mice made obese by the feeding of diets contg. 25% or less fat did not usually develop fatty livers. Strain I mice could not be made obese and did not develop fatty livers.

Water restriction in nutrition studies. I. Level of fat and protein utilization.

SCHREIBER, M., AND ELVEHJEM, C. A. *J. Nutrition, 57,* 133-45 (1955).

The use of high-fat or high-protein diets or both under conditions of H_2O restriction in almost all instances was responsible for larger wt. losses and a greater frequency of fatalities of young rats than occurred with high carbohydrate diets. These results are in part attributed to the little recognized fact that fat, as well as protein, contributes less metabolic H_2O per calorie than carbohydrate.

Weight gain from simple overeating. I. Character of the tissue gained.

KEYS, A., ANDERSON, J. T., AND BROZEK, J. *Metabolism, Clin. and Exptl., 4,* 427-32 (1955).

Twenty men were induced to overeat for 6 mos. on a constant activity regimen and they gained 2.5 to 22.3 Kg. (mean 10.6 Kg.). Body compn. was studied repeatedly, before and at the end, by thiocyanate dilu. space estn. The tissue mass gained proved to be 13 to 15% extracellular fluid, 61 to 64% fat, 0 to 1% glycogen, the remainder being "cells," presumably cytoplasm. The compn. of this "obesity tissue" was independent of the wt. gain over the range 2.5 to 22.3 Kg. The mean energy value of the tissue gained was 6180 cal./Kg. These values are lower in "cells" and higher in fat than the compn. of the tissue gained by men re-fed after prolonged, severe undernutrition.

Hormonal control of amino acid metabolism.

RUSSELL, J. A. *Federation Proc., 14,* 696-705 (1955).

At present it can be said, that of the 3 principal hormones known to be important in this connection; insulin, corti-

(Continued on page 20)

colors that rival nature

ATLAS CERTIFIED COLORS
INDUSTRY'S STANDARD FOR 104 YEARS

FIRST PRODUCERS OF CERTIFIED COLORS

KOHNSTAMM & COMPANY Inc.

ESTABLISHED 1851

89 PARK PLACE, NEW YORK 7 • 11-13 E. ILLINOIS ST., CHICAGO 11 • 2632 E. 54 ST., HUNTINGTON PK., CALIF.

BRANCHES IN OTHER PRINCIPAL CITIES OF THE U. S. A. AND THROUGHOUT THE WORLD

SELECTED ABSTRACTS

(Continued from page 18)

cal hormones, and growth hormone, none appears to be concerned primarily or exclusively with the catabolism of the amino acids *per set* or with gluconeogenesis from the fragments; but instead they all appear to influence some aspect of the synthesis or breakdown of proteins within most or many tissues.

PHARMACOLOGY AND TOXICOLOGY

Effect of aureomycin on liver storage of vitamin A and on growth, depletion and survival time of rats.

MURRAY, T. K., AND CAMPBELL, J. A. *J. Nutrition, 57,* 101-10 (1955).

The effects of aureomycin on storage of vitamin A and on growth, depletion rate and survival of rats were studied. Aureomycin makes available amts. of vitamin A which affect survival time and depletion time but which are not large enough to influence significantly the liver stores.

A laboratory test for bacterial sensitivity to combinations of antibiotics.

JAWETZ, E., GUNNISON, J. B., COLEMAN, R., AND KEMPE, H. C. *Am. J. Clin. Pathol., 25,* 1016-1030 (1955).

A comprehensive test for antibiotic sensitivity must measure both bacteriostatic and bactericidal ability of single drugs or combinations acting on a large bacterial inoculum. Accurate detn. of minimal antibacterial concn. of drug is not essential. A 2-step test is proposed which is comprehensive and adaptable.

IRON TOXICITY

Nutrition Revs., 13, 277-8 (1955).

The result of the expts. indicate that iron toxicity is not the result of local damage to the gastrointestinal tract but rather to metabolic effects of the absorbed iron. The most striking metabolic effect was a profound acidosis. This observation could prove useful in the treatment of iron-intoxicated patients.

PHYSIOLOGY AND MEDICINE

Animal vision.

ROBERTS, S. R. *J. Am. Vet. Med. Assoc., 127,* 236-9 (1955).

Domestic animals are generally short-sighted, have unequally curved corneas, are color-blind, and have little ability to focus. They do have a good night vision, can see a large area at one time, possess a sense of perspective, and have special qualities. Among such are the cat's narrow pupil, the horse's horizontally elongated pupil, and the dog's large pupillary opening.

ENGINEERING AND PLANT EQUIPMENT

Dimensional systems and systems of units in physics with special reference to chemical engineering. II. Practical rules for authors and readers and the need for their observance.

KLINKENBERG, A. *Chem. Eng. Sci., 4,* 167-77 (1955).

In this article the author has suggested rules for the use of empirical, dimensional and dimensionless equations to afford max. clarity. Several examples of poor usage are cited from the literature. The author also discusses advantages and disadvantages of various dimensional systems.

FOOD AND FOOD TECHNOLOGY

CEREALS AND GRAINS

The lipoxidase activity of wheat.

BLAIN, J. A., AND TODD, J. P. *J. Sci. Food Agr., 6,* 471-9 (1955).

The evaluation of lipoxidase activity in exts. of wheat constituents is described and some characteristics of the carotene-bleaching system used were examd. Information on the distribution of the enzyme in the wheat berry was obtained.

Relative nutritive values of proteins in foods and supplementary value of amino acids in pearled barley and peanut flour.

SURE, B. *J. Agr. Food Chem., 3,* 789-92 (1955).

A study on the relative nutritive values of the protein in 14 foods at different levels of intake and during several periods of experimentation. The results are expressed as gains in body wt. of the albino rat per gr. of protein intake. Data are included on the influence of heat and duration of heating on the nutritive value of the proteins in dried nonfat milk solids (skim milk). Data are also recorded on the supplementary value of certain amino acids to the proteins in milled barley and peanut flour.

FISHES

Note on albumin protein fractions in a sturgeon.

DINGLE, J. R., AND DYER, W. J. *J. Fisheries Research Bd. Can., 12,* 646-81 (1955).

The muscle of a sturgeon taken off Nova Scotia contained no trimethylamine oxide. The electrophoretic pattern of the H_2O-sol. proteins indicates at least 10 nondialyzable components in the ext., 2 of which have weak positive mobilities.

LEGISLATION

Part 52. United States standards for grades of concentrated tangerine juice for manufacturing.

AGRICULTURAL MARKETING SERVICE. *Federal Register, 20,* 7281-4 (1955).

Notice of establishment of U. S. S tndards for grades of concd. tangerine juice for manufg., effective 30 days from date of publication.

MILK AND MILK PRODUCTS

Observations on temperature changes in pasteurized milk during bottling, storage and distribution.

RATZLAFF, A. *J. Milk and Food Technol., 18,* 195-9 (1955).

It is essential that milk be properly cooled before being packaged and placed in the cold milk storage room since the temp. of the cold milk storage room may require several hrs. to affect the temp. of the packaged milk to any great extent. It was found that glass bottled milk reacts more rapidly to the cooling effects of the storage room temps. than does paper cartoned milk. In this series of tests the temps. of the milk in the 2 types of cases was never over 3° F. apart during a 7 hr. warming period. There was, however, a slightly greater difference between the temps. of paper cartoned milk when tested in these same types of cases.

SUGARS

Wood molasses.

WAUGH, R. K., MOORE, J. L., LUCAS, H. L., AND FAIRES, E. W. *Research and Farming, 13,* 6 (1955).

In expts. at North Carolina State College, wood molasses shows promise as an important ingredient for the rations of dairy cows. One pound of molasses was worth at least one-half pound of grain.

SUGARS, STARCHES AND SIRUPS

Some effects of dielectric heating on the properties of a cornstarch.

SIMMONS, B. A. *Dissertation Abstr., 15,* 1315-16 (1955).

Study of the effect of dielectric heating on the properties of cornstarch showed a marked change in alkali no., a decrease in iodine affinity no., as well as viscosity changes.

TASTE TESTING

How many taste testers?

BLOM, G. *Wallerstein Lab., Communs., 18,* 173-8 (1955).

Presents and discusses table indicating the no. of panel members required to achieve any desired level of α and β risks for both the "Two-Sample" test and the triangular difference test. Mentions various problems in panel testing and suggests some soln.

INDUSTRIAL HEALTH

Differential susceptibility of animals to dust.

FRANKS, W. R. *Arch. Ind. Health, 12,* 288-96 (1955).

Available data would indicate that there is a reasonable agreement among various animal and human species in regard to the dust retained in the lung. The use of exptl. animals in the bioassay of dust hazards would therefore appear to be valued in this respect. Due to large species variation, however, in regard both

to the toxicity of various substances and to the relative susceptibility to concomitant infection, animal bioassay of industrial hazards has to be interpreted with caution. The continuous accumulation of foreign materials in the lung would appear to have increasing importance with the increasing life span. A given dust hazard must thus be judged in relation to the survival time relative to the exposure. Directly or indirectly it can be anticipated that the pneumoconioses will be of increasing interest to the gerontologists.

Some toxicologic aspects of atmospheric pollution.

NELSON, N. *Am. J. Public Health, 45,* 1289-1301 (1955).

Effects of air pollution can be considered in 3 broad categories: (1) economic loss—an example would be deterioration of merchandise through spoilage; (2) annoyance—odors and eye irritation short of eye damage would be representative; and (3) health impairment or disease. The effects on the respiratory system which appear directly or indirectly to be the major health factor in air pollution are considered.

ORGANIC CHEMISTRY

Structure of collagen.

RAMACHANDRAN, G. N., AND KARTHA, G. *Nature, 176,* 593-5 (1955).

A structure for collagen which is in agreement with infra red spectrum, chem. compn. and x-ray data is proposed.

PACKAGING

New approach to humidity equilibria data.

KAREL, M., AITKAWA, Y., AND PROCTOR, B. E. *Modern Packaging, 29,* 153-6, October 1955.

Recent studies indicate that improved methods for the detn. of equil. relative humidity give highly reproducible results.

PHYSICAL RESEARCH

Intrinsic viscosity and kinematic viscosity.

TANFORD, C. *J. Phys. Chem., 59,* 798-800 (1955).

The paper gives the conversion factor for interrelating intrinsic viscosity with kinematic viscosity (the type yielded by capillary viscosimeters). Protein solns. are emphasized.

Why are multi-point measurements essential?

KLEINERT, J. *Zucker-u. Susswr.-Wirtsch., 7,* 862-64 (1954); *Food Sci. Abstr., 27,* 2034 (1955).

The detn. of a single point suffices only in true Newtonian fluids, the rheogram of which is a straight line, going through the zero point of the coordinate system. In all other fluid systems, at least 2 points are required for the construction of a rheogram for proper characterization. Practical examples of the rheograms for non-Newtonian systems are given and

NATURAL ENZYMES
for food processing

Rohm & Haas commercial enzymes are all natural products . . . and among the most effective aids in food processing.

They are easy to use and are well suited to the mild processing conditions common to the food industry. In service they provide many benefits. For example, they clarify fruit juices, tenderize meats, aid in the production of pre-cooked breakfast cereals, improve the texture of bread, and reduce the viscosity of chocolate sirups.

Rohm & Haas enzymes catalyze specific reactions; unwanted by-products are not formed. And little enzyme goes a long way toward increased production efficiency and greater consumer sales appeal.

Write to Department SP outlining your food processing problem.

A PECTINASE: fruit juices, concentrates, wines

B DIASTASE: bread, cereal-derived products, corn sirup

C PROTEASE: meat, fish, beer

Chemicals for Industry

ROHM & HAAS COMPANY

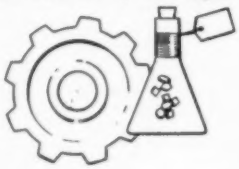
WASHINGTON SQUARE, PHILADELPHIA 5, PA.

Representatives in principal foreign countries

Staley's®

Products from Corn and Soybeans

...from Adhesives to Candy to Textiles, to Paper



a Staley Starch for every purpose!

INDUSTRIAL STARCHES

Textiles, Paper, Candy, Baking, Laundry, Corrugated Boxboard. These and scores of other industries depend on Staley Starch to help make better products for home and industry. They know that starch made by Staley's is quality starch, designed to do a specific job well. There is literally a Staley Starch for every purpose . . . one suited perfectly to *your* needs.

Whether your requirements call for Pearl, Thin Boiling, Moulding, Oxidized, Dextrins, just to name a few of the types, you should see your Staley representative. Not only will he recommend the Staley product best fitted for your process, but will be glad to help in solving many of your own applications and production problems.

You will find the service you receive from your Staley Starch Expert invaluable. Or write us direct for further information on starches made for your specific industry.

For information about other quality Staley industrial products, Corn Syrups, Corn Steep Liquor, Amino Acids, Soy Oils, Soy Flours, Lecithin, etc., write:

A. E. STALEY MFG. CO.
DECATUR, ILLINOIS

PRODUCTS FROM CORN Staley's AND SOYBEANS

SELECTED ABSTRACTS

discussed. The rotatory viscometer measurements of plastic flow, with the necessary adjuvant equipment and thermostats, is described; the method of using the results is explained.

Sorption of macromolecules to solid surfaces: Sorption of dextran to cellulose nitrate membranes in the presence of serum albumin and surface-active agents.

ROTHMAN, S., MANDEL, J., MCCANN, F. R., AND WEISSBERG, S. G. *J. Colloid Sci., 10,* 338-50 (1955).

The sorption of radioactively labeled dextran to collodion membranes was studied in the presence of 0.15M NaCl, serum albumin, and three specific detergents. It was shown that dextran is adsorbed to collodion and that this process is time dependent and may take up to 50 hrs. to reach a stable state. It can be seen that, in order to obtain reliable osmotic pressure measurements with this system, it is necessary to "condition" the membrane to the soln. for a sufficient time to achieve adsorption equil.

A method of determining particle size of powders.

LAKHANPAL, M. L., ANAND, V. D., AND PURI, B. R. *Nature, 176,* 692 (1955).

Describes an app. for detg. the mean diam. of the particles of a powder, applicable to very fine particles.

POLYMER RESEARCH

Precipitation of polymer solutions.

COLBORNE, R. S. *J. Polymer Sci., 18,* 55-62 (1955).

A simple relationship between polymer concn. and precipitability in the system polymer-solvent-precipitant was worked out. A relationship between pptn. methods of evaluating solvent power and other methods involving the coeff. was traced.

Sedimentation of naturally occurring polyelectrolytes.

GORING, D. A. I., AND CHEPESWICK, C. *J. Colloid Sci., 10,* 440-9 (1955).

An invariance of sedimentation rate with mol. wt. was observed between certain concns. for the polyelectrolytes Na carrageenate and Na alginate. This result was explained by assuming a network model which, at low concns., breaks up to permit sedimentation of the mols. individually by applying the Kozeny equation to the flow through the network, the effective specific vol. and surface of the mols. were detd.

RADIOCHEMICAL TECHNOLOGY

Speculations on hazards of exposure to radiations.

KEOSIAN, J. *Science, 122,* 586-7 (1955).

The author believes that the greatest hazard of exposure to radiation is to the present living generation and not to the future generations. He claims that there is no clearly safe dosage for radiation in man and the harmful effect may be cumulative.

Experimental work with radiation sources.

Atomic Energy Newsletter, 14, 4, October 4th, 1955.

Long term feeding of irradiated butterfat in 3 generations of cancer susceptible rats showed no cancer, but a statistically significant drop in fertility among test animals. Attention is drawn to possible destruction of vitamin E.

Reference samples of isotopic abundance.

MOHLER, F. L. *Science, 19,* 334-5 (1955).

The National Bureau of Standards has undertaken a program for the prepn. and distribution of reference samples of isotopic abundance in forms suitable for mass spectrometric analysis. The National Bureau of Standards will serve as a clearing-house for data on the isotopic abundance ratios as measured by cooperating laboratories and will distribute the accumulated data with each sample requested.

New products under development.

Atomic Energy Newsletter, 14, 4, October 4th, 1955.

Professor E. J. Henley of Columbia University has discovered that blue cellophane can be used as a dosimeter for gamma irradiation. The color is bleached out irreversibly with higher dose.

STATISTICS

Experimental design in industry.

HAMAKER, H. C. *Biometrics, 2,* 257-86 (1955).

Some methods of exptl. design are adapted to the particular requirements of industrial expts. Some math. models are given along with their role in the analysis of variance. Also discussed is the form in which the results may best be presented to factory management personnel.

Design and analysis of two phase experiments.

MCINTYRE, G. A. *Biometrics, 2,* 324-34 (1955).

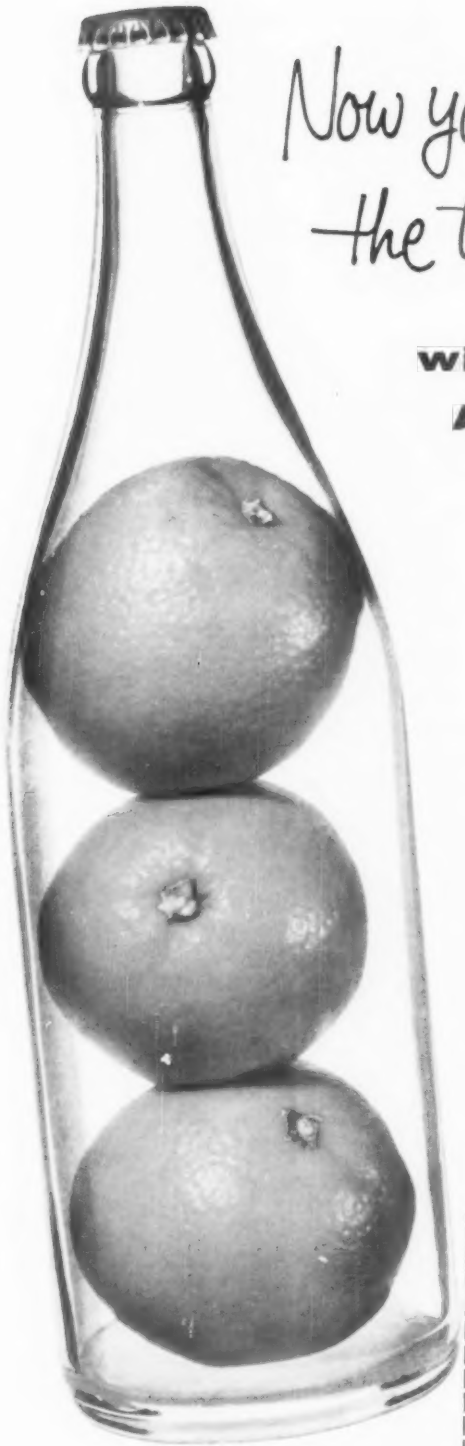
Definitions and practical considerations are given for expts. which require 2 phases. The problem of replication in each phase is discussed and some designs with their analyses are demonstrated.

PATENTS

Process for making maple sirup.

ESKEW, R. K., AND CLAFFEY, J. B. Assignors to the Secretary of Agriculture. 2,718,469, September 20, 1955.

A process for producing maple sirup, comprising concg. the sap to sirup by passing it once rapidly at atm. pressure through an externally heated tubular heater while controlling the heat supplied to the heater so as to cause the sap to be concd. to sirup density during such single passage, followed by holding the sirup at a temp. approximating, but never exceeding its atm. boiling point for the time necessary to develop the desired color and flavor.



Now you can **seal in** the true fruit flavor!

with PFIZER ASCORBIC ACID

. . . protects soft drinks against flavor-fading (and color-fading, too)

● Bottlers who are now adding Pfizer Ascorbic Acid to soft drinks report a significant increase in shelf life. In some tests shelf life has even been *doubled*.

That's because Pfizer Ascorbic Acid successfully counteracts the effects of oxidation—the fading of flavor and color. It does this equally well for either bottled or canned beverages. Does it *safely* and *economically*. And you'll find it's a cinch to add Pfizer Ascorbic Acid when you prepare your syrups.

In citrus drinks where the oxidation problem can be severe, color-fading and flavor-fading are easily detected. *For less than a cent a case* Pfizer Ascorbic Acid will keep the flavor of these and other drinks fresher far longer. (In fact, it often actually *enhances* the natural flavor!) And it cuts down the color-fading caused by sunlight storage, too.

Why not protect the sales of your products this simple way? Test the effectiveness of Pfizer Ascorbic Acid in your own flavors and formulas. Pfizer Technical Service men will be glad to help you. Write for our *Technical Bulletin 86*.

Chas. Pfizer & Co., Inc., Chemical Sales Division
630 Flushing Ave., Brooklyn 6, N.Y.

Please send me ☐ *Technical Bulletin 86*
☐ *a 125-gram sample of Pfizer Ascorbic Acid.*

Name_____

Title_____

Company_____

Address_____

City_____ Zone____ State_____

T

Manufacturing Chemists for Over 100 Years

Pfizer

CHAS. PFIZER & CO., INC.
Chemical Sales Division
630 Flushing Ave., Brooklyn 6, N.Y.
Branch Offices: Chicago, Ill.; San Francisco, Calif.; Vernon, Calif.; Atlanta, Ga.; Dallas, Tex.

Regional Section News

NORTHEAST SECTION

The annual Ladies' Night meeting of the Northeast Section was extremely well attended—124 members and guests. It was held at the Hotel Beaconsfield, Brookline, Mass. on Thursday evening, December 1.

The large turnout was a tribute to the featured speaker, Dean Samuel C. Prescott. To add further to

Dr. Prescott is shown during presentation of gavels and certificates of appreciation. Receiving his award is Dr. Arthur C. Fay, past Chairman.
Photo Credit: Lawrence S. Spiegel

the festivities of the evening, twelve past-chairmen of the Northeast Section were honored at a gavel-presentation ceremony.

Dean Prescott is universally recognized and acclaimed as an outstanding figure in the field of Food Technology. A graduate of M.I.T. in 1894 with a B.S. in Chemistry, he is noted for his studies on thermal processing for the canning industry. Former Dean of the School of Science at M.I.T. he is the holder of two honorary degrees of Doctor of Science and the recipient of the Appert Medal in 1943 and the Babcock Award in 1948.

Shown listening to Dr. Prescott are, left to right—W. Leverett Cummings, NE Chairman; Dr. Jean F. Caul, NE Past Chairman; Dr. Samuel A. Goldblith, NE Vice Chairman; Dr. Carl R. Fellers, Past National Chairman, and hidden behind Dr. Prescott, Dr. Bernard E. Proctor, Past National Chairman.
Photo Credit: Lawrence S. Spiegel

As first President of I.F.T. he was well qualified to speak on the "Origin and History of I.F.T." His paper traced the formative background, the strong growth in a mere 17 years, and its present importance as one of the leading national scientific and professional societies in the technological field.

The Northeast Secton was the third regional entrant into the fold and has been the host of two national conventions, has provided three national presidents, and has established a competitive award for students of food technology.

CHICAGO SECTION

At 6:00 P.M., 12 December 1955, 174 members and guests enjoyed a cocktail hour in the Illinois Room of the Palmer House. An exceptionally fine dinner was served in the Chicago room: soup, salad and chicken, topped off with fruit parfait, petit fours, and the always delicious Palmer House coffee.

Convening in the Crystal Room, the members and guests heard Chairman Jackson express the Section's appreciation to Grover Steffen for his excellent arrangements. Dr. Jackson then paid tribute to the Companies whose generosity made possible the refreshments and door prizes.

Stan Brockington led the community sing—an annual feature of the Christmas meeting. Sixteen lucky persons were awarded door prizes.

C. F. Evers introduced Dr. Jean F. Caul who spoke on the subject "Flavor's New Look." Dr. Caul began with the early history of flavors and the part they played in geographic discoveries. Recognizable flavor characteristics are few in number and are usually found in various combinations. Using a very descriptive but easily understood technology, Dr. Caul explained the housewife's approach to modifying the flavors of such foods as spinach, lamb, and liver. Flavor panels studied eight products which had in common that each led its particular field and had 70% of the market. As additional common characteristics, the flavor of each individual product was immediately evident and "came through" as a blend not as an individual flavor. The sensation then disappeared leaving no greasy mouth coating.

OHIO VALLEY SECTION

On November 18, the Section held its Fall Meeting at the Biltmore Hotel, Dayton, Ohio. The afternoon session consisted of a symposium of short talks on food fats, mellorines, meat treatment, baking technology, and food technology from the consumer's standpoint. These papers were aimed at providing a refresher course in current food technology and projected developments.

The guest speaker for the evening was Mr. Ferris S. Owen of Newark, Ohio, and Vice-President of the Ohio Farm Bureau who gave an illustrated talk on his experiences in visiting Russian farms and food centers. Mr. Owen was one of a group of fifteen American farmers selected to make a six-week tour of Soviet Russia during the summer of 1955. This tour took our speaker over 10,000 miles inside the Soviet Union—through the Ukraine, Crimea, Siberia, and Asiatic Russia as well as Moscow and other urban areas. In addition to providing information about agricultural procedures, Mr. Owen did an outstanding job of apprising the group of the Russian way of life, their food habits, economy and educational programs.

(Continued on page 26)

at long last...

an **IMITATION RASPBERRY**

with right-off-the-bush flavor!

GIVAUDAN'S NEW IMITATION RASPBERRY FLAVOR is an achievement long desired throughout the flavor-using industries.

Developed with painstaking care through many years of research, it duplicates with all of its fugitive and delicate nuances the rich flavor of the ripe raspberry as it comes fresh from the bush!

This new Givaudan development provides you with an opportunity to enhance—with true economy—the appeal of your raspberry-flavored products. Its high concentration and proved stability make it ideal for virtually every type of product in which raspberry is a popular flavor. We invite your inquiries.

Givaudan Flavors Inc.

330 West 42nd Street, New York 36, N. Y.

Branches: Philadelphia • Boston • Cincinnati • Detroit
Chicago • Atlanta • Seattle • Los Angeles • Toronto

REGIONAL SECTION NEWS

(Continued from page 24)

OREGON SECTION

On December 9, 1955, a meetng was held in Salem, Oregon, which proved to be one of the outstanding meetings of this Section. The group gathered at the plant of the Willamette Cherry Growers, Inc., Salem, at 3:00 p.m. for a tour of the plant. This is the largest cherry brining plant in the world where cherries are bleached and prepared for finishing as maraschino cherries. During the peak of the summer operation, the plant receives 500 tons of cherries a day and places them in sulfur dioxide brine solution in a matter of a few hours. There are 167 brining tanks with a capacity of 27 tons each in addition to thousands of barrels. Eighty-five percent of the cherries processed are Royal Anne variety. The brined cherries are shipped nation-wide

Mr. Ian J. Tinsley, Oregon State College, receiving Florasynth Award Plaque from Mr. Eliot Friberg of the Florasynth Laboratories, Inc.

Speaker of the evenir —Mr. Bernard Mainwaring, Publisher, Capital Journal, Salem, Oregon.

in barrels, tank cars and tank trucks. There are 860 cherry growers in the organization and the plant is managed by Mr. Robert E. Shinn assisted by his son Bill. Coffee and doughnuts were served at the plant and at 5:30 the members met at the China City Restaurent, Salem, for dinner and a very interesting evening.

Florasynth Laboratories, Inc., was very ably represented by Mr. Eliot Friberg, Western Regional Manager, 2309 E. Eighth St., Los Angeles, California. Mr. Friberg told about some of the products and activities of his own company, pointing out the diverse food and other products that contain flavors and aromatics manufactured by Florasynth. The approximately 50 members and guests were impressed by the scope of activities of Florasynth Laboratories. Mr. Friberg then presented a plaque to Mr. Ian J. Tinsley, winner of the 1955 $1,000 Florasynth Award and expressed his pleasure in being able to make such a presentation.

Mr. Tinsley is a graduate student in the Food Technology Dept., Oregon State College. He came from Sydney, Australia, where he had obtained a Bachelor of Science Honors Degree in 1949 at Sydney University and had been employed as a Research Officer in the Australian Commonwealth Scientific and Industrial Research Organization, Division of Food Preservation and Transport.

Mr. Tinsley spoke for a few minutes in thanking the Florasynth Company for making the award possible and expressed his appreciation to everyone else who had a part in the award. He particularly appreciated the thought behind such an award and hoped that other awards could be set up in the field of Food Technology in that there are many students that are very deserving of such a morale booster and such a substantial material benefit.

The principal speaker of the meeting was introduced by Mr. Alton C. McCully, Eugene Fruit Growers, Vice-Chairman of the Oregon Section. He was Mr. Bernard Mainwaring, Publisher of the Capital Journal newspaper, Salem, Oregon, and member of the State Board of Higher Education of Oregon. Mr. Mainwaring is a graduate of Oregon State College and was editor of several newspapers in Oregon and Idaho before purchasing the Capital Journal in 1953. As a special sideline to his many other activities, Mr. Mainwaring, since 1927, has been studying and speaking on the subject of the politics of nominating presidential candidates—not the election of the candidates, but the pre-convention jockeying of the nominees and political parties. He listed the qualifications of each potential nominees for presidential candidate of both parties and pointed out factors that will be taken into consideration at the nominating conventions next summer. He was a very interesting speaker and warmly received by the group.

PUGET SOUND SECTION

At the Section's first fall business meeting held October 19, 1955, at Hewitt's Cafe in Seattle, Washington, results of the recent election were announced. Officers elected to serve this section for 1955-1956 are as follows:

Chairman: Glenn M. Danielson, Supervisor, Quality Control, Nalley's Inc., Tacoma, Wash.

Chairman-elect: John Spinelli, Chemist, Food, Chemical, and Research Laboratories, Inc., Seattle, Wash.

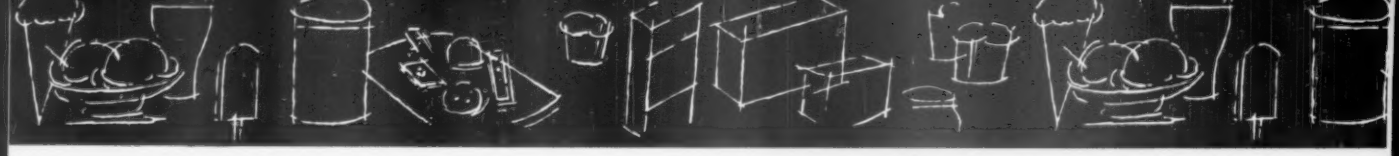
Secretary: Martha A. Poolton, Research Department: In Charge, Quality Control, Washington Co-Operative Farmers' Association, Seattle, Wash.

Treasurer: L. P. Callahan, Laboratory Manager, Libby, McNeill and Libby, Seattle, Wash.

National Councilor: Clarence Hurlbut, Food Technologist, Blue Banner Foods, Kent, Wash.

Executive Committee (1955-1957 term): Robert W. Johnson, Northwest Chemical Representative, Charles Pfizer Company, Incorporated, Seattle, Wash.; William Wayman, Chemist, American Can Company, Seattle, Wash. Serving second year, 1954-1956 term: John A. Ardussi, Industrial Chemical Company, Issaquah, Wash.; Arthur J.

(Continued on page 28)

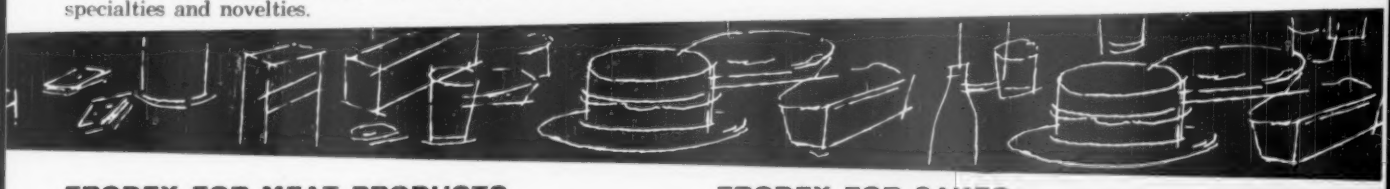


FRODEX FOR ICE CREAM

Used by a majority of the country's manufacturers for over two decades, Frodex has numerous advantages for ice cream and ice cream specialties. Flavor is enhanced, texture is smoother, heat shock tolerance increased, total solids content is built up, melt-down is improved when Frodex is used in ice cream, stick novelties, sherbets, low fat and other specialties and novelties.

FRODEX FOR PIE CRUSTS

Improved crust color all the way through, faster baking with better color development, improved flake, elimination of soggy crusts through greater stability and crispness, enhanced flavor – all advantages you gain when you use Frodex in pie crusts.



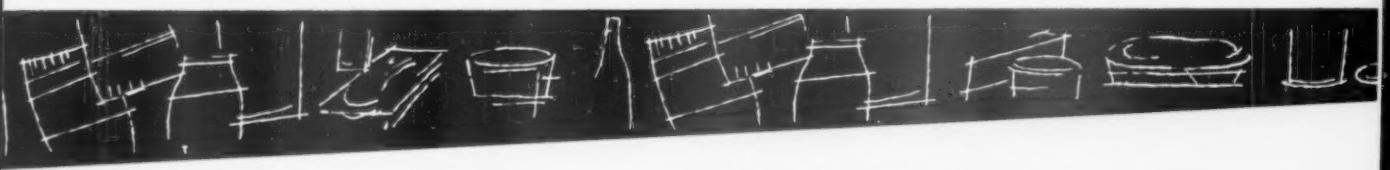
FRODEX FOR MEAT PRODUCTS

Frankfurters · Sausages · Prepared Luncheon Meats

Frodex minimizes loss of color during processing and storage. It is an excellent moisture conditioner for longer shelf life, promotes better texture, less shrinkage and minimum watering-off. Frodex is a better binding agent for better appearance, stabilizes the fat-content of meat products as an emulsifying agent.

FRODEX FOR CAKES

Frodex helps increase volume, produces a finer grain and smoother texture, helps maintain oven freshness for longer shelf life, enhances flavor through its mellowing effect, produces a richer golden brown crust color and lowers production costs with increased yield.

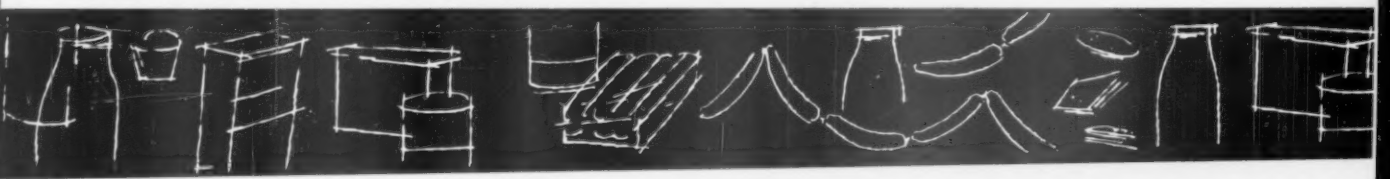


FRODEX FOR DRY FOOD MIXES

In soups, icings, cake and pie mixes, dessert mixes, drinks, muffins, pancake mixes and similar dry food products, Frodex offers a number of distinct advantages both in production of the mix and in the finished product.

FRODEX FOR CATSUP

Frodex enhances natural color, retards oxidation, particularly in the neck of the bottle, and does not mask the true condiment flavors of the catsup.



FRODEX corn syrup solids FOR BETTER FLAVOR, BETTER FOODS, BETTER SALES

Pure white dehydrated corn syrup produced by a unique patented process, Frodex (corn syrup solids) is a thoroughly proven ingredient. Tasteless and odorless, Frodex is easily incorporated, speeds production and improves the quality of almost every food. Our Research and Technical Service Laboratories are constantly developing new uses for Frodex. Their facilities, together with the skills of our chemists and technicians, are at your disposal. Do not hesitate to call upon them, without obligation.

FRODEX IS AVAILABLE IN BOTH REGULAR (POWDERED) AND GRANULAR FORM

AMERICAN MAIZE-PRODUCTS COMPANY

250 PARK AVENUE • NEW YORK 17, N. Y.

ATLANTA · BOSTON · BROOKLYN · BUFFALO · CHICAGO · DENVER · FORT WORTH · GRAND RAPIDS · LOS ANGELES
MEMPHIS · PHILADELPHIA · PITTSBURGH · PORTLAND · ST. LOUIS · ST. PAUL · SAN FRANCISCO · SEATTLE

Whichever fat you use for mono, molecular distillation makes it work better

Distilled monoglycerides are now in production made from:

cottonseed oil	vegetable oleic acid
soybean oil	hydrogenated lard
lard	hydrogenated soybean oil
edible tallow	

Distilled monoglycerides made from the following have been produced on a semi-commercial scale:

peanut oil
hydrogenated cottonseed oil
vegetable palmitic acid

The way we purify them by our unique molecular distillation process gives all these monoglycerides something in common: an unusually high monoester content, and an almost complete freedom from fatty acids, catalysts, and other impurities that degrade taste and odor and inhibit emulsifying properties. Which oil makes the best monoglycerides for your purpose depends on what you want it for. The best way to find out is by making comparative tests on the formulation problems that confront you with a complete set of samples. You get samples of distilled monoglycerides made from the oils listed above by writing to ***Distillation Products Industries,*** Rochester 3, N. Y. Sales offices: New York, Chicago, and Memphis • W. M. Gillies and Company, Los Angeles, Portland, and San Francisco • Charles Albert Smith Limited, Montreal and Toronto.

distillers of monoglycerides made from natural fats and oils

DPi

Also . . . vitamin A in bulk for foods and pharmaceuticals

Distillation Products Industries
is a division of **Eastman Kodak Company**

REGIONAL SECTION NEWS

(Continued from page 26)

King, Chief Chemist, Fisher Flour Mills Company, Seattle, Wash.

At the November meeting held November 15, 1955, at the Student Union Building, University of Washington, Seattle, an interesting and informative program on "Frozen Food Quality Control" was presented by two members of the quality control staff of the Stokely-Van Camp, Inc. plant located at Mount Vernon, Wash.

Mr. E. Terry Dalton, Assistant Manager of the Research and Quality Control Frozen Food Division of Stokely-Van Camp, junior past chairman of the Seattle Section, American Society for Quality Control, spoke on "Organization and Method in Quality Control." Mr. Dalton discussed economics or quality-cost ratio, consumer acceptance, and assurance of quality standards as universal principles of quality control.

Use of chart patterns to show quality variations from standard was explained by Mr. Dalton. Data which must be compiled for each product in order to employ the chart procedure include definition and classification of defects, establishment of product specifications, determination of acceptable quality levels related to lot quality, and formulation of the process standard which will assure that lot specifications are met. Through organizing for quality with use of statistical methods, the Research and Quality Control Division of his company has gained a better understanding of quality control principles, quality factors, and increased ability to effectively put management views into action, Mr. Dalton stated.

Mr. Charles R. Sheaffer, Quality Control Supervisor, Research and Quality Control Division, Stokely-Van Camp, 1955-1956 chairman of the Seattle Section, American Society for Quality Control, spoke on "Examples of Statistical Quality Control Applications." Mr. Sheaffer discussed application of the statistical method to various fruit and vegetable products processed by his company.

A major part of the work is process control, Mr. Sheaffer stated, in which appearance and weight of material, mechanical efficiency of machines, and ratio of components in mixed packs are all important factors. Finished products, developmental formulas, and competitive products are regularly analyzed in taste panels. Each particular area of product checking is given careful study to assure an effective quality control program at Stokely-Van Camp, Inc.

SOUTHERN CALIFORNIA SECTION

The Section met December 14 at the Rodger Young Auditorium for the final meeting of 1955. Dr. Max Dunn, our 1954 chairman, introduced the speaker of the evening, Dr. A. J. Haagen-Smit, Professor of Chemistry at Cal-Tech. Dr. Haagen-Smit spoke to us about the perfume industry. He pointed out that it was one of the oldest industries in the history of man, supporting this statement with references from the Bible. He traced the use of perfumes throughout the ages by

(Continued on page 30)

For good health, the American people must ingest at least 60 tons of vitamin A per year. Over 10% of this they get from margarine.

Shortly after margarine fortification began in the 1930's, when the vitamin was commercially available only from fish liver oils, DPi began its vitamin A service to the industry, continuing smoothly into the present era of Myvax Vitamin A Palmitate and Acetate. For quotations and technical data on these superior synthesized products in cans of Myvapack Vitamin A adjusted to individual batch requirements, write *Distillation Products Industries*, Rochester 3, N. Y. Sales offices: New York, Chicago, and Memphis • W. M. Gillies and Company, Los Angeles, Portland, and San Francisco • Charles Albert Smith Limited, Montreal and Toronto.

"Myvax" and "Myvapack" are trademarks

leaders in research and production of vitamin A

DPi

Also . . . vitamin E . . . distilled monoglycerides
. . . some 3500 Eastman Organic
Chemicals for science and industry

Distillation Products Industries *is a division of* **Eastman Kodak Company**

REGIONAL SECTION NEWS

(Continued from page 28)

the use of slides depicting various Egyptian, Greek, and other scenes clearly indicating the use of scented materials. He then brought the story up to date with references to the complex structure and synthesis of some modern perfume materials, such as musk and mimosa.

The new officers for 1956 were then introduced. They are: Chairman, Gordon Merchant; Vice Chairman, E. B. Oberg; Secretary, James Ritch; Treasurer, Sam Carlat (re-elected).

NORTHERN CALIFORNIA SECTION

The Section held its annual all-day meeting on December 8 at the Western Utilization Research Laboratory, Albany, Calif. The annual banquet was held at Spenger's Fish Grotto, Berkeley. Following is a list of the papers given at the all-day session:

The Effect of the Soy Yeasts on the Flavor of Soy (Shoju)—Toshio Nakahama, Dept. of Agricultural Chemistry, Saikyo University—Japan.

Instrumentation in The Food Industry—Wm. J. Scarlett, Food Industry Manager, Minneapolis-Honeywell Regulator Company, Philadelphia, Penn.

Foods of Tomorrow—Robert W. Smith, Manager Company Development Research, Stanford Research Institute.

Application of Radioactive Isotopes in the Food Industry—Abel De Haan, Chemistry Department, Tracerlab, Inc., Richmond, Calif.

Consistometry—Dave Eolkin, Gerber Products Company, Oakland, Calif.

Control of Vinegar Flies in Picked Tomatoes—E. S. Doyle, J. R. Kimball, N. A. Olson, National Canners Association, Berkeley, Calif.

Liquid Ferment in Bread Making—Wm. H. Ziemke, Fairfax Bread, Safeway Stores, San Francisco, Calif.

A Review of the Technique and Theory in Vinegar Manufacture—Ernest Mayer, Hunts Food, Hayward, Calif.

Microbiological Hazards of Precooked Frozen Foods— R. P. Straka and J. L. Stokes, Western Utilization Research Branch, Albany, Calif.

Studies on Factors Contributing to Consistency of Apricot Puree—Martha E. Davis, Western Utilization Research Branch, Albany, Calif.

Factors Influencing Corrositivity of Dry Prunes—J. C. Connell, American Can Company, San Francisco, Calif.

Preferences in Canned Cling Peach Sweetness—Marion Simone, University of California, Davis, Calif.

Occasional Pinkness of Well Cooked Roast Poultry Explained—M. F. Pool, Western Utilization Research Branch, Albany, Calif.

Color Changes in Strawberry Preserves—Lukton, Chichester and MacKinney, University of California, Berkeley, Calif.

Pectin Development in Ripening Fruit as Determined by Radioisotope Techniques—C. G. Seegmiller, Western Utilization Research Branch, Albany, Calif.

Storage Deterioration of Tomato Juice—B. S. Luh, Sherman Leonard, and G. L. Marsh, University of California, Davis, Calif.

Lycopene in Tomato Products—G. S. Bohart, Western Utilization Research Branch, Albany, Calif.

New Developments in Rice Drying—A. H. Brown, Western Utilization Research Branch, Albany, Calif.

Gamma Radiation of Beef, Pork, Poultry and Fish—A. L. Tappel and Dr. Groniger, University of California, Davis, Calif.

Physiological and Chemical Changes in Potatoes Irradiated with Gamma Rays—Sigmund Schwimmer, Western Utilization Research Branch, Albany, Calif.

Moisture Determination of Foods by Hydrogen Nuclei Magnetic Resonance—R. H. Elsken, Western Utilization Research Branch, Albany, Calif.

B. Grossi was Chairman of the morning session while the afternoon meetings, divided into two sections, were chaired by M. A. Joslyn and Hans Lineweaver. Following the papers, R. Stewart of Dow Corning, Berkeley, showed a film on "Silicones" after which the W.U.R.L. was toured. Dr. Paul L. Kirk was the after-dinner speaker who spoke on "Physical Micro Chemistry Meets the Criminal."

ST. LOUIS SECTION

Word comes from Mr. Paul Logue, Chairman of the Section, that the Fourth Annual Food Technology Short Course will be held March 16 and 17, 1956, on the Campus of the University of Missouri. This popular course is sponsored jointly by the University of Missouri College of Agriculture and the St. Louis Section. Locus of the meetings is the Memorial Student Union, University of Missouri, Columbia. Reservations should be made with Mr. Paul Logue, Chairman, St. Louis Section, care of Monsanto Chemical Company, 710 North 12th Boulevard, St. Louis, Missouri.

MARYLAND SECTION

On November 11th the Maryland and Philadelphia Sections met jointly at the new Chestnut Run Laboratories of the DuPont Company. While there the groups were led on a well-described tour of the Sales Technical Laboratories of the Film Division. By "film" is meant the familiar types of packaging films on the market today, including Mylar.

The Laboratories were well equipped with various humidity and temperature controlled rooms each for a specific condition. They also contained interesting electronic and electrical equipment to test and indicate the properties of the film and the foods protected.

After the tour was completed, the members refreshed themselves and became better acquainted at the DuPont Country Club where cocktails were served. Later they enjoyed a dinner there, after which Dr. Nelson Allen of the DuPont Company educated everyone on the technical aspects of "Film Packaging." He embellished his talk with slides as well as a sound movie. Foremost among his subjects was Mylar—the newest film. He not only described the physical qualities of this and other films, but emphatically pointed out the need for selection of the proper film for any specific product and condition.

Everyone seemed to enjoy this joint meeting and we can easily suggest it to other sections.

At the December 9th meeting, the following officers were elected:

Chairman: William J. Hart, Jr., John H. Dulany & Son, Inc., Fruitland, Md.

Vice Chairman: William A. Feild, Federal Yeast Corporation, Baltimore 24, Md.

(Continued on page 35 following technical papers)

PRIZE-WINNING BUTTERMAKERS PREFER DIAMOND CRYSTAL FLAKE BUTTER SALT!

MEMO
FROM WILLIAM FOSTER

Jim --

It looks like these Diamond Crystal people make a salt with just the right purity and grain size for every purpose.

Don't you think it would be a good idea to find out how Alberger Salt can help improve our operation?

Bill

Mr. Donald Hedding, of the Hillsboro Cooperative Creamery Co., Hillsboro, Wis., First Prize Winner for Sweet Cream Butter in the 1954 National Butter Scorings at the National Dairy Cattle Congress, Waterloo, Iowa. His butter won the same award in 1950. In both 1949 and 1950, Donald Hedding's sweet cream butter won First Prize in all classes of the Wis. State Fair.

rystal Flake Butter Salt for over 10 years," says prize winner Donald Hedding. "Because Diamond Crystal's 'soft flakes' consistently do the best job in buttermaking of any salt I've ever seen! I'm sold on the way it dissolves quickly and completely in butter . . . leaves no grittiness. Diamond Crystal Flake Butter Salt never requires extra-long working which can produce mottled, sticky butter. It has a pure salt flavor that never imparts a strong, brackish flavor to butter. I've seen what it can do," says champion Donald Hedding, "and that's why it's my choice!"

Prize-winning butter is the result of many factors—skill born of long experience, painstaking care, good equipment and quality ingredients.

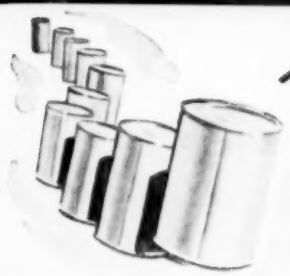
Diamond Crystal Flake Butter Salt helps you make better butter because:

- **It's the only Butter Salt made by the exclusive Alberger Process of refining which produces unique, quick-dissolving flake crystals!**
- **It's pure—highest uniform purity assures true salt flavor!**
- **It's uniformly sized—precision screening produces flakes that are just the right size and solubility for good buttermaking!**
- **It's clean—the lowest insoluble content of any butter salt!**
- **It's low in heavy metals—less than 1.5 parts per million of pro-oxidants copper or iron!**

DIAMOND CRYSTAL FLAKE BUTTER SALT

America's Largest-Selling High-Grade Butter Salt!

For further information, write to: Dairy Dept., Diamond Crystal Salt Co., St. Clair, Michigan



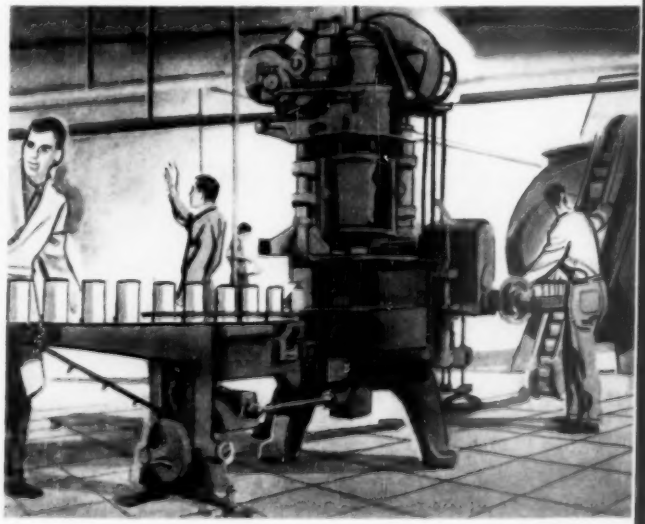
Men who feed America

1. Many of the people who operate the canneries work in small towns—to be near the crops they pack. At planting time they are available to advise the grower on fertilizers and sprays, and even on choice of seeds. Many canners are also growers, packing crops from their own fields or orchards.

2. The canner must estimate the size of crops while they are still in the soil. Then he worries, along with the grower, over possible blights or storms. While he readies packing machinery, he studies temperature charts to determine when to expect the first picking. Early ripening calls for fast action.

5. Peeling, blanching and similar operations are done by machines that seem to be almost human. But inspectors' eyes are alert to catch any product deviations from standard. In "the season," the canner snatches only winks of sleep, being always on call as crops are speeded into freshly-washed cans.

6. Can lids are seamed on tight, sometimes under vacuum, closing at the rate of hundreds per minute. Each can becomes, in effect, a miniature pressure cooker. Fast cooking in the hermetically-sealed can preserves vitamins, texture and flavor. After cooling, cans are labeled, coded and cased for shipment.



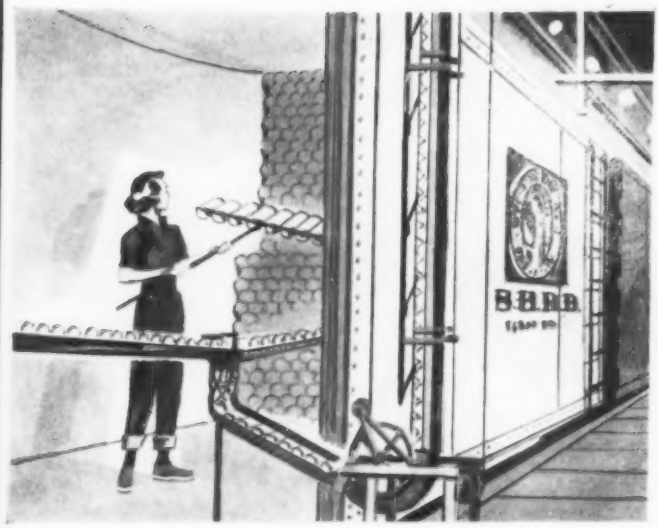
PUBLISHED AS A TRIBUTE TO

The Canners of America

49th annual convention
The National Canners Association
—Atlantic City,
January 19 to 21

(This advertisement originally appeared in full-color in TIME, BUSINESS WEEK and FORTUNE.)

Here is the dramatic story of men who bring the nation's crops to your table all year around. Because canners work hard and conscientiously, you benefit by having a wide variety of nutritious foods always readily available wherever you live.

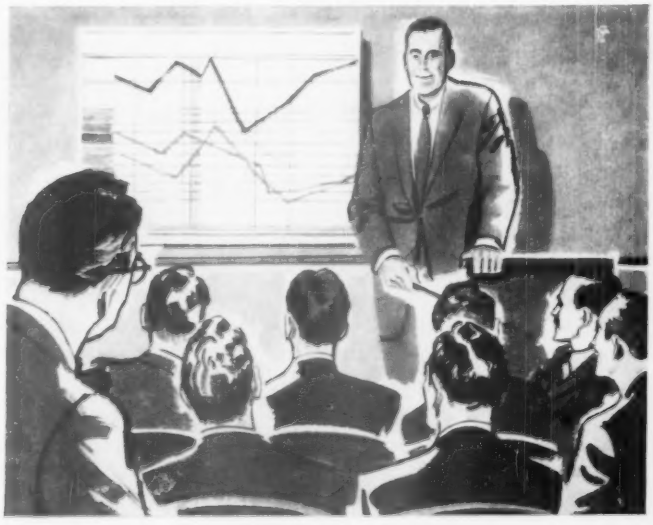


3. Cans must be ready—not too many, not too few. Since warehouse space is limited, the canner relies on a constant incoming flow of empty cans. Occasionally, trucks hauling away cases of freshly-packed canned foods bring new can supplies from a nearby Continental plant on their return trip.

4. The crops are ripe and ready! As they come into the cannery, they are inspected for color, quality and texture. The canner, whose reputation is at stake, watches these inspections with close attention. Only perfect fruits and vegetables will be worthy of receiving his or his customer's brand name.

7. While various crops follow one another through the cannery, the canner is arranging for their distribution. All through the year he works with his own and brokers' salesmen, and with the buyers at chain-store offices. So at every season of the year you will find good canned foods in plentiful supply!

8. Canners participate in many state, regional, and national meetings. They hear industry specialists, college and government scientists, marketing men discuss mutual problems. One such meeting at Atlantic City commemorates the 50th Anniversary of the first Federal Food and Drugs Act.



CONTINENTAL CAN COMPANY

Serving the Canning Industry of America

Tin Cans
Fibre Drums
Crowns & Cork
Paper Containers
Flexible Packaging
Conolite®

Decoware®
Plastic Bottles
Steel Containers
Vynite Tubes
Bondware®
Plastic Pipe

New possibilities for continuous processing!

...with Foxboro sanitary proportional flow control

Foxboro Magnetic Flow Meter . . . transmits flow measurement to recorders or controllers.

You no longer have to discard new ideas in continuous process design for want of adequate flow control! Foxboro now provides the first complete sanitary proportional flow control system ever available.

Heart of this system is the Foxboro Magnetic Flow Meter. It has proved highly successful in measurement of widely varied food products including beer, tomato products, apple juice, and grape juice. And it's equally applicable to many others, such as egg yolks, wine—even molasses! It measures *magnetically*, with no flow interference, no pockets, crevices, or projections to collect residue or contamination. And its high accuracy is sustained, despite variations in conductivity, density, and viscosity.

The Dynalog Controller and the Saniflo Valve complete the system . . . offer a complete sanitary control "package". Send us *your* flow control problem. Write **The Foxboro Company, 352Norfolk St., Foxboro, Mass., U.S.A.**

A complete, sanitary proportional flow control package

Foxboro Magnetic Flow Meter. Accurately measures the flow of virtually any liquid except non-conductors like chocolate, fats and oils. Installs easily in the line like any equivalent length of pipe. No taps, seals, purges, meter runs, or straightening vanes required. Connects by 2-conductor cable to remote Dynalog Controller.

Foxboro Dynalog Recording Controller. Responds instantly to changes in volume flow, initiates fast, accurate valve action to hold pre-set rate. Troublefree, stepless measuring circuit has no slidewire — requires no standardizing or batteries, practically no maintenance. Control action can be air-operated or electric-operated.

Foxboro 2-way Saniflo Control Valve. A streamlined valve for liquids, suspensions, viscous or pulpy materials. Equally effective for throttling (proportional) or open-and-shut control. One-piece stem and plunger — no threads or crevices to harbor bacteria. Quick-disconnect clamp for easy cleaning. Can be replaced in control system by other type valve or a pump to meet process requirements.

FOXBORO
REG. U.S. PAT. OFF.

SANITARY FLOW CONTROL

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

Nutritional and Biochemical Effects of Irradiation[a]

R. R. BECKER, H.-C. KUNG, N. F. BARR, CONSTANCE S. PEARSON, AND C. G. KING
Department of Chemistry, Columbia University, New York, N. Y.

(Manuscript received July 8, 1955)

Experiments carried out in many laboratories have shown clearly that certain essential nutrients are destroyed to varying degrees when subjected to sterilizing doses of radiation *(2, 3, 6, 7, 11)*. It has been amply demonstrated also that undesirable changes in flavor, odor, color, and texture may occur, but it is hoped that these difficulties may be overcome. It is of obvious importance, also, that the chemical changes produced by ionizing radiation do not lead to injurious, unwholesome, or carcinogenic compounds. Little information derived from long-term feeding experiments is available to give indications as to whether or not such changes occur. This paper presents some of the results of a long-term feeding experiment carried through three generations of experimental animals, as well as certain data regarding destruction of specific nutrients.

A large amount of information regarding reproduction and longevity has been accumulated over a period of years on continuing generations of albino rats of the Sherman strain fed a diet composed of ground whole wheat, whole milk powder, and salt. It is known, too, that this strain of experimental animals is susceptible to certain carcinogenic agents. The test diet was prepared by mixing 53 g. of irradiated butterfat (1.68×10^6 rep in a Co^{60} source), and 147 g. of skim milk powder, in substitution for 200 g. of whole milk powder, as used in Professor Sherman's experiments. The other dietary components were 1000 g. of ground whole wheat and 20 g. of salt. Both the control and experimental groups received vitamin A and D supplements.

When animals of the same litter reached 63 days of age, they were placed in breeding cages (one male per female). Pregnant females were separated to single cages until their offspring reached 28 days of age; then the mother was put back in the original cage. In the first generation, 6 females each were used in the control and experimental groups. Thirty-two rats, 16 males and 16 females, of the second generation (matched offspring of the first generation) and the same number from the third generation were tested in the same way. The rats were weighed once a week. Other data were recorded on the basis of daily observations of all animals.

Growth data for the males of three generations are shown in Figures 1, 2, and 3. The growth pattern was similar in all groups, and, although the control groups

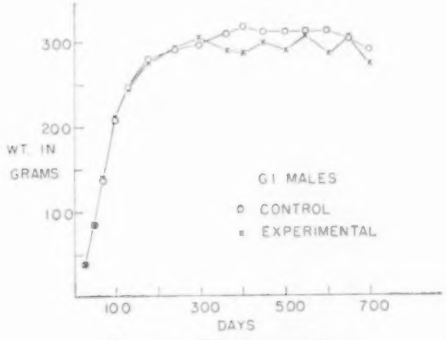


Figure 1. First generation.

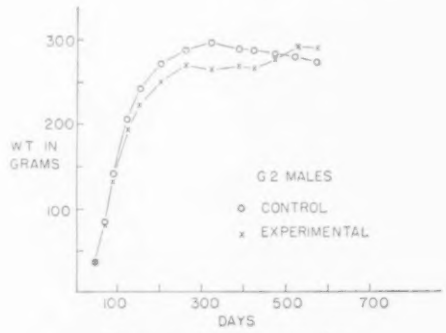


Figure 2. Second generation.

in the first and third generations showed slightly greater gains in weight, the differences were not significant.

Figure 4 includes the growth curves for females of 3 generations up to the age of 70 days. It is evident that no significant difference was found in this respect, nor was there a significant difference in the average weight

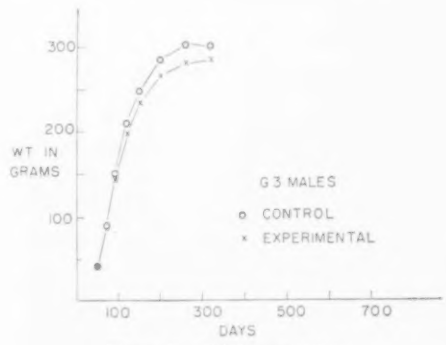


Figure 3. Third generation.

of young at 28 days, as shown in Table 1. The slight differences in body weight of the young at 28 days were favorable to the control groups, however, in the 3 successive generations.

All females of the initial group (first generation) proved to be fertile. Forty-one litters, with 280 young, were delivered by the 6 control females, compared with 28 litters and 193 young, by the six experimental

[a] Presented at the Fifteenth Annual Meeting of the Institute of Food Technologists, Columbus, Ohio, June 15, 1955.

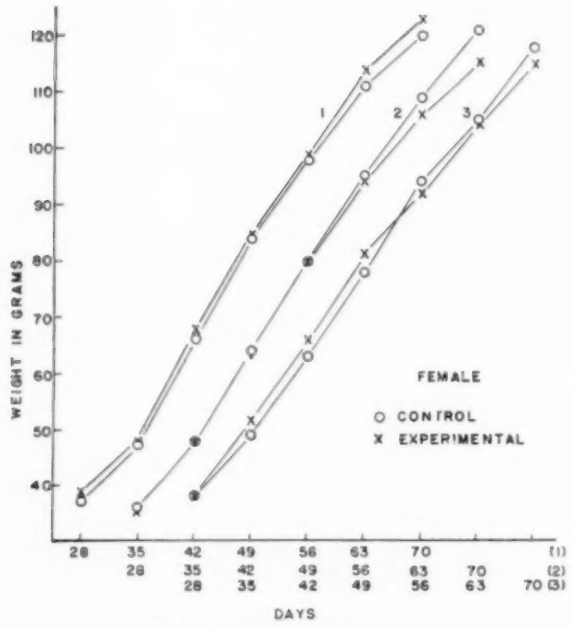


Figure 4. Growth of females.

females (Table 1). This difference, 13 litters and 87 young, is statistically significant.

The results obtained from the breeding records of the second and third generation rats were similar to those from the first generation, except that the differences between the control and experimental groups were less significant than in the first generation, as is shown in Tables 1, 2, and 3. The breeding period of the second

TABLE 1

Generation	I		II		III	
Diet	control	irrad.	control	irrad.	control	irrad.
Number of females mated	6	6	8	8	8	8
Number of litters born	51	38	47	39	40	33
Number of young born	283	193	307	293	269	239
Number of young reared[1]	239	151	264	262	215	215
Number of females reared[1]	131	87	135	142	109	108
Number of males reared[1]	108	64	129	120	106	107
Average body weight of young at 28 days	39	37	42	39	41	38

[1] Young rats were reared to 28 days of age, then either kept for experiment or sacrificed.

generation females was almost complete when the experiment was terminated. One female of this group on the experimental diet was sterile.

Sixty-two animals, those surviving at the end of the experiment, were autopsied and examined for pathological changes by Dr. Benjamin Berg of the Columbia College of Physicians and Surgeons. All the pathologic changes found were essentially the same in control and in experimental animals and they occurred with equal frequency in both groups. There was not a single instance of carcinogenesis, although this strain of animals is known to be susceptible to certain carcinogens. In view of the extensive experience of the pathologist

TABLE 2
Number of litters per female

Generation	Control	Experimental
	mean P.D.[1]	mean P.D.[1]
I	6.8 ± 0.5	4.7 ± 0.6
II	5.9 ± 0.7	4.9 ± 0.8
III	5.0 ± 0.5	4.1 ± 0.5

[1] Probable deviation of the mean.

TABLE 3
Number of young per female

Generation	Control	Experimental
	mean P.D.[1]	mean P.D.[1]
I	46.7 ± 4.2	32.2 ± 4.8
II	38.4 ± 4.6	36.6 ± 5.4
III	33.6 ± 4.3	29.9 ± 3.7

[1] Probable deviation of the mean.

who examined the tissues, the great variety of lipid constituents in butterfat, and the length of time during which the experiment was continued, we regard the clearly negative findings as being highly significant.

The reasons for the slightly poorer performance of the animals on the partially irradiated diet are not clear. Work in other laboratories in addition to our own, has shown that vitamin E is radiation-sensitive, and others have reported that a deficiency developed in animals fed an irradiated dietd *(9)*. We are currently checking this point in feeding experiments similar to those just described, in which vitamin E is being given independently as a supplement. The results are not yet definite. The composition of the diet was such that one would not expect a deficiency of vitamin E to occur unless the residual peroxides in the irradiated butterfat, upon mixing, destroyed the tocopherols present in the ground wheat, which contains about 2 mg. of the vitamin/100 g. Dr. Stanley Ames of Distillation Products Industries has kindly analyzed our irradiated butterfat, as well as wheat germ oil by both a chemical method and by bioassay. Chemical assays indicated a slight (apparent) increase in the tocopherol content of both products after irradiation. However, bioassays showed over 80% destruction of the vitamin in butterfat, and about 15% destruction in wheat germ oil. These data are summarized in Table 4.

The formation of peroxides and other oxidative changes in fats have been demonstrated in several laboratories *(4, 5, 8, 10)*. In connection with our feeding experiments, we have also determined peroxide values

TABLE 4

Assay	Wheat Germ Oil		% Destruction	Butterfat		% Destruction
	Untreated	Irradiated[1]		Untreated	Irradiated	
Chemical, mg./g. (total tocopherol)	1.34	1.51		0.049	0.061	
Bioassay, mg./g. (d-α tocopherol)	0.92	0.79	14	0.031	0.005	82
Bioassay, I. U./g. (dl-α-tocopherol acetate)	1.06	0.92	13	0.036	0.006	83

[1] Dose: 1.2×10^6 rep.

in several fats, including butterfat, which has been more extensively studied by Hannan *(2, 3, 5)*. Typical data are summarized in Figure 5. It is apparent that under these conditions, the amount of peroxide (μg./g.) increases with increase in dosage (69,000 rep per hour). A slight increase in the acetyl value of irradiated butterfat was found (controls, 6.1, 6.1, 4.9; irradiated at 1.7×10^6 rep, 7.3, 7.3 and 6.1 respectively). Whether or not this slight change in apparent hydroxy acids would have an effect on our experimental animals is not known.

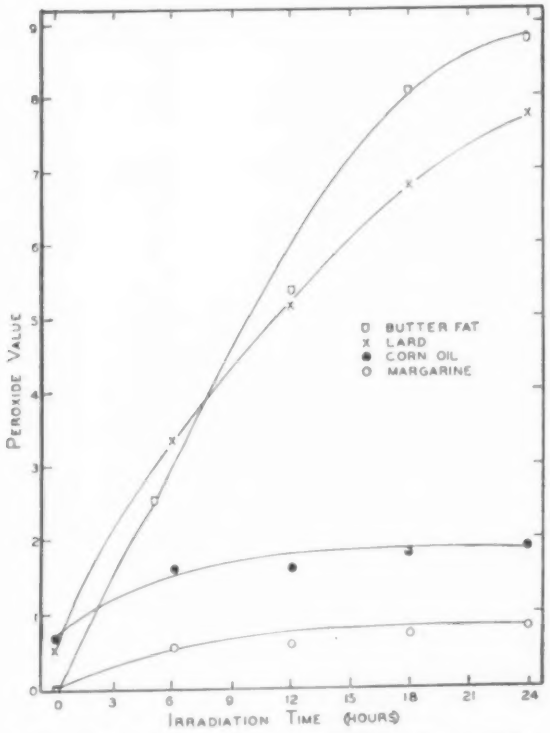


Figure 5. Effect of γ-rays. Peroxide production in several fats.

The radiation-induced destruction of essential nutrients and of enzymes in foods has been studied quite extensively *(2, 6, 7, 11)*. The results of such studies have shown that the vitamins are destroyed in widely varying degrees, and that, in general, enzymes are relatively stable. Typical results of tests on milk are shown in Figure 6.

Vitamin A and ascorbic acid were highly sensitive to destruction within the time period required for sterilization. Carotenoids and riboflavin were moderately sensitive. The enzyme phosphatase, however, which is very sensitive to heat inactivation, was only slightly changed during identical exposures. Similar results were obtained with raw whole milk, cream, margarine, and cheese. Extensive destruction of ascorbic acid by ionizing radiation has been reported also by Proctor and O'Meara *(12)*.

We have studied in detail the oxidation of ascorbic acid to the dehydro form as an example of a class of

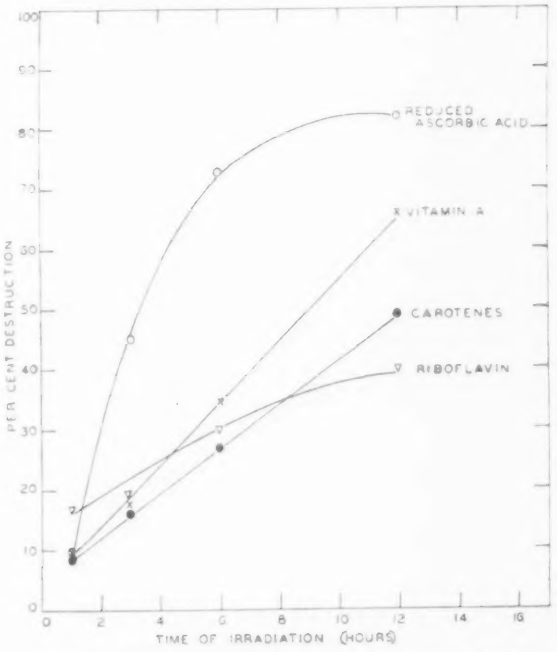


Figure 6. Effect of γ-rays on vitamins in evaporated milk. Dose = 80,000 rep/hr.

compounds commonly used for the inhibition of oxidative changes that occur upon irradiation. In these studies, initial rate data at low dosages were obtained, and interpreted on the basis of the ferrous-ferric reaction under similar conditions *(1)*. The stoichiometry of the reaction, including data on the amount of oxygen consumed, leads to a postulated mechanism as follows:

$$H_2O \longrightarrow H\cdot + \cdot OH$$
$$H\cdot + O_2 \longrightarrow HO_2\cdot$$
$$AH_2 + \cdot OH \longrightarrow H_2O + AH\cdot$$
$$AH_2 + HO_2\cdot \longrightarrow H_2O_2 + AH\cdot$$
$$AH\cdot + O_2 \longrightarrow AHO_2\cdot$$
$$AHO_2\cdot + AH\cdot \longrightarrow 2A + H_2O_2$$
$$2AH_2 + 2O_2 \longrightarrow 2A + 2H_2O_2$$

The absence of chain utilization of oxygen is consistent with the known protective effect of ascorbic acid and other easily oxidizable substances, such as thiourea, tocopherol, and hydroquinone, on biological systems. These substances apparently exert their protective action by limiting extended chain utilization of oxygen.

SUMMARY

A long-term feeding experiment with albino rats, in which the butterfat portion of the diet consisting of five-sixths whole ground wheat and one-sixth powdered whole milk, was irradiated from a Co^{60} source (dose = 1.68×10^6 rep), has shown no evidence of carcinogenicity in three generations of animals. Growth rates of the test and control groups showed no significant differences, although slight differences tended to favor the control groups.

The reproductive performance of animals on the partially irradiated diet was below that of the control group, for reasons not yet clear. The difference for the first generation groups was higher than the later values (2nd and 3rd generations).

Oxidative changes in several fats similar to those reported by other laboratories have been found, including a marked rise in peroxides and a slight increase in acetyl values.

Nutrient loss was greatest in ascorbic acid and in the fat soluble constituents, vitamin A, carotenes and vitamin E. Enzyme inactivation tends to be very slight, relative to nutrient destruction at sterilizing dosage, when radiation is compared with heat effects. Hence a relatively mild combination of both may offer advantages over either, alone, in specific products.

Acknowledgment

These investigations were supported by the U. S. Atomic Energy Commission Contract AT (30-1)-1186, Office of the Surgeon General Contract DA-49-007-MD-550, and The Nutrition Foundation, Inc., New York, N. Y.

LITERATURE CITED

1. Barr, N. F., and King, C. G. *J. Am. Chem. Soc.*, **76**, 5565 (1954).
2. Hannan, R. S. The Preservation of Food with Ionizing Radiations. *Food Science Abstracts*, **26**, 121 (1954).
3. Hannan, R. S. In Special Report No. 61, Department of Scientific and Industrial Research, Food Investigation, London, 1955.
4. Hannan, R. S., and Bong, J. W. *Nature*, **169**, 152 (1952).
5. Hannan, R. S., and Shepherd, H. J. *Brit. J. Radiol.*, **27**, 36 (1954).
6. Hayner, J. H., and Proctor, B. E. *Food Technol.*, **7**, 6 (1953).
7. Kung, H. C., Gaden, E. L., Jr., and King, C. G. *J. Am. Food Chem.*, **1**, 142 (1953).
8. Mead, J. F. *Science*, **115**, 470 (1952).
9. Poling, C. E., Warner, W. D., Humburg, F. R., Reber, E. F., Urbain, W. M., and Rice, E. E. *Food Research*, **20**, 193 (1955).
10. Polister, B. H., and Mead, J. F. *J. Am. Food Chem.*, **2**, 199 (1954).
11. Proctor, B. E., and Goldblith, S. A. *Food Technol.*, **5**, 9 (1951).
12. Proctor, B. E., and O'Meara, J. P. *Ind. Eng. Chem.*, **43**, 718 (1951).

The Development of Instant Milk[a]

D. D. PEEBLES

Western Condensing Company, Petaluma, California

(Manuscript received September 8, 1955)

The dry milk industry is currently witnessing a revolution. The time-honored use of dry milk has been in bread and a few other manufactured foods. More recently, however, it has come into more direct food use, in the production of cottage cheese and ice cream. Since World War II we have also seen a tremendous growth in its use in the home (Figure 1).

Still the volume of dry milk used in the home is relatively small and there is a good reason. All of those who have studied the problems of dry milk utilization realize that the products available, until a short time ago, had some serious defects. Probably most important of these are: poor wettability, unsatisfactory pouring characteristics and a tendency to cake.

The process described here produces a non-fat dry milk without these objectionable features. It has excellent flavor and shelf life. It is readily and conveniently reconstitutable. It possesses good pouring characteristics and is non-caking. The case of wetting is outstanding.

The process. A great deal of time and effort went into the development of the process for the product just mentioned. Well over 30 years elapsed between the conception of the "instant milk" idea and the perfection of the commercial process. For a good many years attempts were made to modify the spray drying process itself to achieve the desired end. It was never possible to produce products that met the standards that had been set up for the final product. Another attack on the problem was to modify commercially spray dried

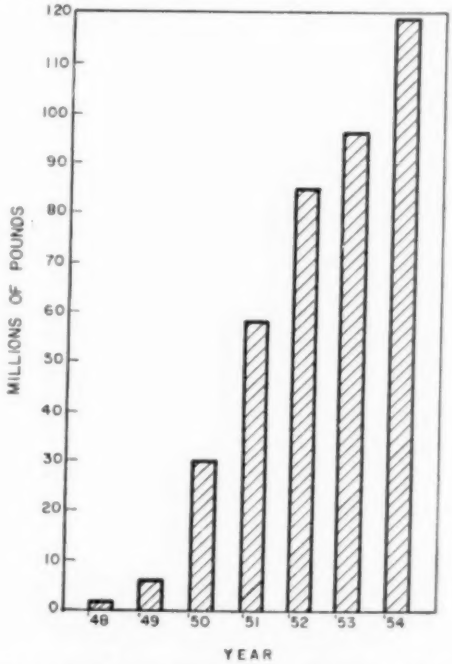


Figure 1. Sales of non-fat dry milk for home use.

[a] The *Food Engineering* Award Address, presented at the Fifteenth Annual Meeting of the Institute of Food Technologists, Columbus, Ohio, June 14, 1955.

products. Here success was achieved and fortunately the process and equipment turned out to be relatively simple and inexpensive.

In essence the process consists of the controlled moistening and redrying of commercially spray dried non-fat milk. Figure 2 shows a schematic drawing of the equipment involved; it should serve to make a description of the process more meaningful.

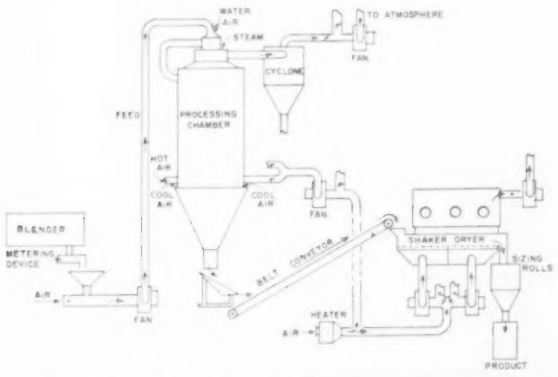


Figure 2. Schematic drawing for instant milk process.

The first step is to blend the various lots of milk solids being used as raw material. This naturally makes for more uniformity in the final product as well as in the control of the processing to follow. The product is next metered into a pneumatic conveyor and delivered to the top of the main processing chamber.

In this chamber the milk powder comes in intimate contact with finely atomized water and fully saturated air (with steam). Shortly thereafter the product falls into a countercurrent flow of cool air and finally falls onto a conveyor belt.

The moistened milk powder is next conveyed to a shaker type of dryer. In this unit the moisture is lowered to the desired level (3.5-4.0%) by forcing heated air through a moving bed of the product. A specially designed vibrating screen serves as a conveyor and air inlet for this redryer.

After removing the moisture the product is standardized as to particle size and is then ready for packaging.

While the instant process and the necessary equipment are quite simple, a great deal of care is needed to successfully produce acceptable products in commercial quantities. Obviously, rigid control of raw material is essential. Since most of the instant products are used for beverage purposes the milk solids purchased for conversion must be high quality, low-heat, spray dried products. Routine quality control on these include: moisture, fat, solubility index, bacteria count, and flavor.

Care must be taken in the operation of the main processing chamber: Control of air flow, air and water temperatures, atomization of the water, etc. The emerging product must be a well hydrated, spongy mass. Experience has shown that time-temperature relationships are important. There must be proper control to secure adequate hydration (permitting crystallization of lactose and development of an open, porous structure) before redrying. If excessive temperatures or times are employed the milk proteins will become denatured and rendered insoluble.

Improper incorporation of moisture will result in lumpiness and uneven distribution, the latter resulting in a final product which will not pour nicely or reconstitute readily and which will show some tendency to cake.

During redrying the moisture must be removed without causing heat damage, resulting in loss of solubility and in flavor changes. Also it must be done without breaking up the spongy character developed in the main processing chamber; as indicated above this is important to good dispersibility. With the shaker dryer this is accomplished by control of drying air temperature and gentle conveying by vibrating action.

Properly carried out, the final product has all of the desired properties; excellent flavor and shelf life, rapid and easy reconstitution, good pouring characteristics, and is non-caking.

Figures 3a and 3b are photomicrographs of non-fat milk solids before and after processing. The changes in

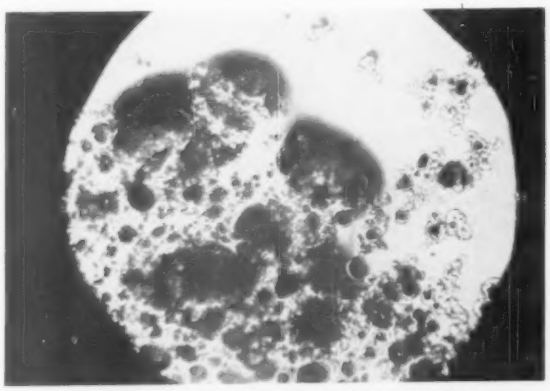


Figure 3a. Non-fat dry milk before processing.

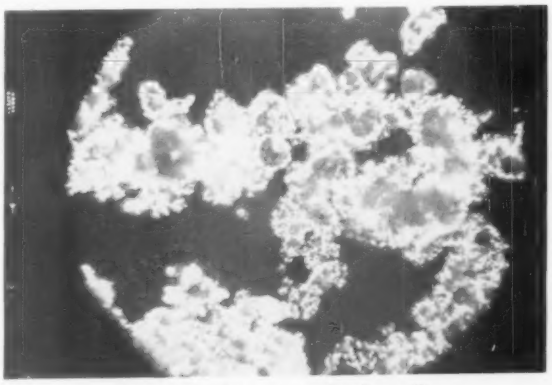


Figure 3b. Instant non-fat dry milk.

structure are very apparent. The structure is very open and there are large aggregations of the small particles. Under a polarizing microscope the birefringent property of the crystalline lactose is readily made out.

Rapid Procedures for Approximation of Bacterial Counts in Shrimp and Oysters[a]

A. F. NOVAK, E. A. FIEGER, AND M. E. BAILEY

Department of Agricultural Chemistry and Biochemistry, Louisiana State University, Baton Rouge, Louisiana

(Manuscript received September 20, 1955)

Two methods for rapid approximation of bacterial counts in shrimp and oysters are described. Measured samples of products to be tested are added to media capable of supporting definite physiological conversions. These transitions occur rapidly and are measured by observing color changes. Time required to reach the end point is indicative of the bacterial count.

Lack of laboratory facilities or technically trained personnel in seafood industries instigates the development of fast scientific tests requiring only minor equipment and simple application of fundamental chemical knowledge. Standard plate count procedures requiring 48 to 72 hours are definitely too time consuming prior to processing and packaging many foods. Quick methods are essential to determine if it is safe to continue processing a product, or whether it should be rejected. Such tests have been developed, and are here described, for the rapid approximation of bacterial counts in shrimp and oysters. These tests should be applicable to other food products having counts within certain ranges.

One method involves growth of the microorganisms in a carbohydrate-containing medium; the rapid formation of acid, which is proportional to the number of bacteria present in the added sample, furnishes the indicant for the test and the basis of measure. Acid formation is readily measured by observing the color change in an indicator added to the medium.

Another method found to be successful is a modification of the methylene blue reductase test. It differs from the milk test in that rapid counts on numerous other products can be made by employing a single medium *(1)*. Sterilized, nonfat dry milk solids in solution serves merely as a medium, and is not the source of any microorganisms. In this determinatioin, time required for reduction of methylene blue in a synthetic medium by bacterial reductases is measured. The length of time required is an indication of the number of bacteria present in an added sample.

EXPERIMENTAL

I. Acid Production Method

A bacteriological medium was formulated for rapid acid production by bacteria, having the following composition:

Tryptone	0.25 g.
Proteose peptone (Difco)	0.5 g.
Bacto-beef extract	0.1 g.
Dextrose	0.15 g.
Lactose	0.5 g.
Maltose	0.5 g.
Yeast extract	0.05 g.
Sodium chloride	0.5 g.
Bromthymol blue	0.005 g.
Distilled water q.s.	100.0 ml.

Final pH is adjusted to 7.10 prior to sterilization, and falls to near pH 6.9 during autoclaving. Sterilization is accomplished by autoclaving tubes containing 5 ml. medium at 250° F. (121° C.) for 15 minutes. After cooling to room temperature, the tubes are ready for use.

Unwashed, headless shrimp, with shell and viscera intact, and shucked whole oysters procured from local processors were the products used in this investigation.

Shrimp are not subjected to any preliminary treatment before testing, but increased uniformity of oyster samples is obtained by homogenization in a Servall Omni-Mixer.

Samples for counts are then prepared by diluting approximately 40 g. of oysters or shrimp with a sufficient amount of sterile water, pH 7.0, to make a total volume of 200 ml., and mixing for two minutes in a Waring Blendor. An aliquot of 5 ml. represents 1 g. of sample.

Actual determinations of approximate bacterial counts are made merely by introducing a measured volume of sample into a tube of medium, and incubating at 95° F. (35° C.). Time required for the production of a definite amount of acid (signified by the formation of a yellow color) indicates the approximate bacterial count.

Interpret the count from the following:

Time for color change	Approximate count × 10^6 per tube at start of test
Less than two hours	10 or more
Between 2 to 2.5 hours	5 to 10
More than 2.5 hours	5 or less

RESULTS

Results obtained on several representative samples are presented in Table 1. Plate counts were made according to standard procedures for comparative purposes *(2)*.

TABLE 1

Bacterial counts in shrimp and oysters (Acid production method)

Sample no.	Material	Time for color change	Rapid count × 10^6 per g.	Plate count × 10^6 per g.
1	oysters	1 hr. 45 min.	above 10	12.4
2	oysters	2 hr. 10 min.	above 5	8.2
3	oysters	2 hr. 25 min.	above 5	6.1
4	oysters	2 hr. 40 min.	below 5	4.3
5	oysters	3 hr. 5 min.	below 5	2.8
6	oysters	3 hr. 25 min.	below 5	1.1
7	shrimp	1 hr. 40 min.	above 10	12.7
8	shrimp	2 hr. 10 min.	above 5	7.7
9	shrimp	2 hr. 15 min.	above 5	7.2
10	shrimp	2 hr. 35 min.	below 5	4.8
11	shrimp	2 hr. 55 min.	below 5	3.4
12	shrimp	3 hr. 15 min.	below 5	2.0

[a] This investigation was supported in part by grants-in-aid from the Fish and Wildlife Service, U. S. Dept. of Interior, Louisiana Wildlife and Fisheries Commission, and the Shrimp Association of the Americas.

EXPERIMENTAL

II. Reduction Method

A medium containing the following constituents is prepared for this test:

Nonfat dry milk solids	0.5 g.
Distilled water q.s.	100.0 ml.

Final pH is adjusted to 7.0 prior to sterilization. Tubes containing 5 ml. of medium are autoclaved for 15 minutes at 250° F. (121° C.). After cooling to room temperature the tubes are ready for use.

A standardized methylene blue solution is made by adding one standard tablet [b] to 200 ml. distilled water.

To perform the test, introduce 0.5 ml. of the standard methylene blue solution into the medium along with a measured volume of sample. A 5 ml. aliquot representing one gram of sample is recommended. Immediately incubate the tube at 95° F. (35° C.), and by frequent observation note the time required for the disappearance of the blue color. Use a methylene blue free control to facilitate reading the end point. This tube should contain the same amount of the sample and medium. Satisfactory results are also obtained if the methylene blue is added to the milk medium prior to sterilization.

Interpret the count from the following:

Time for color change	Approximate count × 10^6 per tube at start of test
Less than 1 hour	10 or more
Between 1 and 2 hours	5 to 10
More than 2 hours	5 or less

RESULTS

Results obtained on several representative samples are presented in Table 2. Plate counts were made according to standard procedures (*2*).

[b] Standard methylene blue tablets used in this experiment were from the National Aniline Company and may be purchased from laboratory supply houses.

TABLE 2

Bacterial counts in shrimp and oysters (Reduction method)

Sample no.	Material	Time for color change	Rapid count × 10^6 per g.	Plate count × 10^6 per g.
1	oysters	50 min.	above 10	12.4
2	oysters	1 hr. 15 min.	above 5	8.2
3	oysters	1 hr. 45 min.	above 5	6.1
4	oysters	2 hr. 10 min.	below 5	4.3
5	oysters	2 hr. 35 min.	below 5	2.8
6	oysters	2 hr. 55 min.	below 5	1.1
7	shrimp	40 min.	above 10	14.3
8	shrimp	1 hr. 10 min.	above 5	7.7
9	shrimp	1 hr. 45 min.	above 5	6.3
10	shrimp	2 hr. 15 min.	below 5	4.3
11	shrimp	2 hr. 30 min.	below 5	2.5
12	shrimp	3 hr. 5 min.	below 5	0.9

DISCUSSION

More accurate readings can be obtained for any particular product by preparing a graph plotting actual plate counts against rapid count time.

Bacterial counts of 5 and 10 million were selected for the purpose of this investigation because they cover the apparent range causing early spoilage of these products by bacterial decomposition. Higher or lower values could be selected for other products where sufficient data are available, or can be obtained, to show counts above which a specific food product is likely to be of poor quality after packaging.

These tests are practical because they are simple to perform, and require only minor skill by the analyst. It is recommended that sealed, sterile tubes of medium be made available for the determination. This factor would reduce the probability of error and simultaneously serve to standardize the test. Later, methods for determining specific organisms which might be found to increase the velocity of spoilage, could be incorporated into the tests.

The major difficulty at present is in attempting to obtain uniform samples. Further investigations will be made to find improved means of sampling.

Different laboratories should determine their own standards according to the conditions employed and types of food products tested. If pH of samples of substances to be tested vary within a wide range, it may be advisable to adjust the sample pH to obtain uniform reaction conditions.

SUMMARY

Procedures for rapid determination of bacterial counts in oysters and shrimp are presented. In one method the degree of acid formation in a standardized medium is indicative of the number of bacteria present in an added sample. Another method concerns the time required for reduction of methylene blue by organisms present in a sample added to a basal medium. These reactions occur rapidly and are measured by observing color changes.

Other products may be tested by these techniques, although minor modifications should be made as required.

LITERATURE CITED

1. American Public Health Association. *Standard Methods for the Examination of Dairy Products.* 1948, New York, N. Y.
2. American Public Health Association. *Standard Methods for the Examination of Water and Sewage.* 1946, New York, N. Y.

The Effect of High Temperature Storage on the Content of Salmonella and on the Functional Properties of Dried Egg White[a,b,c]

GEORGE J. BANWART[d] AND JOHN C. AYRES

Food Processing Laboratory, Iowa Agricultural Experiment Station, Iowa State College, Ames, Iowa

(Manuscript received October 15, 1955)

The effect of moisture content and temperature of storage of dried albumen on the viability of S. senftenberg, S. oranienburg, and S. pullorum and on solubility, specific gravity of meringue and angel-cake-making properties of the reconstituted product is studied. It is shown that albumens can be stored at elevated temperatures (50°, 60° or 70° C.) to eliminate Salmonella without significant impairment of functional properties.

It is well known that *Salmonella* are pathogenic for man and hence constitute a health hazard when present in foods. Reports by several workers *(5, 9, 11, 19, 26, 30)* have shown that these organisms have been isolated from egg products.

Many methods have been suggested to reduce or eliminate the load of *Salmonella* or of other organisms from egg products. These include (a) plant sanitation *(6, 15)*; (b) pasteurization of the liquid egg *(10, 12, 31, 33)*; (c) storage of the dried product *(2, 13, 14, 16, 17, 20, 28, 32)* and (d) use of atmospheres containing carbon dioxide *(22, 23, 24)*.

A report by Osborne *et al. (25)* showed that *Salmonella* were isolated from dried whole egg that was pasteurized prior to drying. Thus, it would seem that pasteurization is not a dependable procedure for eliminating *Salmonella* from the dried product. Storage of dried albumen at elevated temperatures to free the egg of pathogens, as suggested by Ayres and Slosberg *(2)*, would prove beneficial in that this process minimized recontamination due to handling.

In order to be acceptable as a method for eliminating *Salmonella* from dried albumen, storage at elevated temperatures should not be detrimental to the product. Ayres and Slosberg *(2)* indicated that the storage conditions they used did not impair the functional properties of the dried albumen while the increased temperature of storage aided in the destruction of *Salmonella*.

The present study was conducted in order to determine the effect of moisture content of the albumen, and the temperature and time of storage on the population of *Salmonella* and on the functional properties of pan dried and of spray dried albumens.

METHODS AND MATERIALS

Preparation of dried albumens. The strains of *Salmonella* chosen for this investigation were *S. pullorum* (WURB 3083), *S. oranienburg* (WURB 6266) and *S. senftenberg* (775W). Studies by other workers *(25)* had shown that these 3 strains respectively had slight, moderate, and high resistance to heat in liquid whole egg. Also, 2 of the 3 species represented are commonly occurring contaminants of poultry products.

For pan dried albumen, fresh eggs obtained from the Iowa State College Poultry Farm were broken and separated by the use of a commercial breaking tray and separator. After separation, the whites were blended in a Waring blender at 50 volts for 60 seconds as described by Carlin and Ayres *(7)* and enzyme treated (Deoxygenase)[e] to remove the glucose *(8)*. Enzyme treatment was continued until the rapid plate method *(4)* showed that insufficient glucose was present to give the browning reaction.

The *Salmonella* were grown on an agar surface in a Roux culture flask at 37° C. for 24 hours. The cells were washed free from the surface and inoculated into the fermented liquid whites. This inoculated liquid was then pan dried by the method described by Carlin and Ayres *(8)*.

Spray dried albumens were obtained from commercial egg processing plants. Inoculation of *Salmonella* in the liquid albumen prior to drying was conducted as described for pan dried whites. The liquid was then spray dried in accordance with procedures considered by industry to give albumen having acceptable functional properties. After drying, the powder was immediately transported or shipped to Ames and stored in a 4° C. refrigerator until used.

Storage of dried albumen. The dried albumen obtained from the drier usually contained from 6 to 8% moisture. In order to reduce the moisture content below this level, the material was dried in a vacuum oven set at 30° to 35° C. To increase the moisture content, the albumen was placed in a sealed box in which a fan circulated air over a pan of water until the desired amount of moisture was obtained. For preliminary experiments, moisture contents ranging from 1.8 to 18% were used; the moisture levels chosen for further study were 1.5, 3, 6 and 12%. The percent moisture was determined by the vacuum oven method *(1)*.

After moisture adjustment, the albumens were placed in 2-ounce screw capped bottles. The filled bottles were sealed with tackiwax and placed in an incubator set at the desired temperature.

Storage temperatures of 50°, 60° and 70° C. were chosen for this investigation since it had been found in preliminary studies that *Salmonella* survived at 45° C. for excessive periods of time. Also, in 1911, Maurer *(21)* had reported that the solubility of dried egg powder was reduced very rapidly at 75° C. but that heating at 70° C. did not result in drastic changes.

[a] A report of work done under contract with the U. S. Department of Agriculture and authorized by the Research and Marketing Act of 1946. The contract is being supervised by the Western Utilization Research Branch of the Bureau of Agriculture and Industrial Chemistry.

[b] Journal Paper No. J-2814 of the Iowa Agricultural Experiment Station, Ames, Iowa. Project No. 970.

[c] Address presented at the 14th Annual Meeting of the Institute of Food Technologists, Los Angeles, California, June 28, 1954.

[d] Present address: Food Technology Department, University of Georgia, Athens, Georgia.

[e] Takamine Laboratories, Clifton, N. J.

Bacteriological examinations. Bacteriological examinations of the powders were made in order to determine the incidence of *Salmonella*. An MPN technique was used wherein 5 tubes of Selenite-F were inoculated for each dilution and, after incubation, loopfuls of broth from the tubes were streaked on brilliant green agar. Since the original numbers of *Salmonella* in the several albumens varied, it was difficult to compare the effect of the conditions imposed merely by observing the number of survivors. Therefore, death rates (or velocity constants) were calculated by using the formula $K = \frac{1}{t} \log \frac{I}{F}$ (K = death rate, t = time in days, I = initial numbers and F = final numbers). Initial death rates were determined at the end of 24 hours of storage.

Functional tests. The solubility, whipping ability and angel cake-making properties of the stored albumens were measured. For solubility determinations a modification of the procedure described by Stuart *et al. (29)* and Kline *(18)* was used. Three grams of albumen were reconstituted in 100 ml. of water for 30 minutes and, after shaking, the mixture was filtered through Whatman No. 12 filter paper. The percent solids in the filtrate was determined by the vacuum oven method *(1)*. The test described by Slosberg *et al. (27)* was used to determine whipping ability; also angel cakes were baked and volumes measured by the method described by Carlin and Ayres *(7)*.

RESULTS AND DISCUSSION

Microbiological Changes

The percent survivors of *S. oranienburg* in pan dried albumen adjusted from 1.8 to 18% moisture and stored at 50° C. are presented in Figure 1. After 12 days of storage there was a noticeable difference in the percent of cells surviving in albumen containing 3% moisture when contrasted with the percent surviving in albumen having 6% moisture. No *Salmonella* were isolated from albumens with moisture levels above 10% on the 12th day of storage. The percent of survivors was considerably greater in albumen having 3% moisture than was the case in albumen with 6% moisture on the 38th day of storage. Since these results indicated that levels of 3% and 6% were critical, these two moisture concentrations were selected for further study. Moisture levels of 1.5% and 12% were selected in order to provide a geometric series representing reasonable minimum and maximum moisture concentrations that might be encountered in commercial albumen.

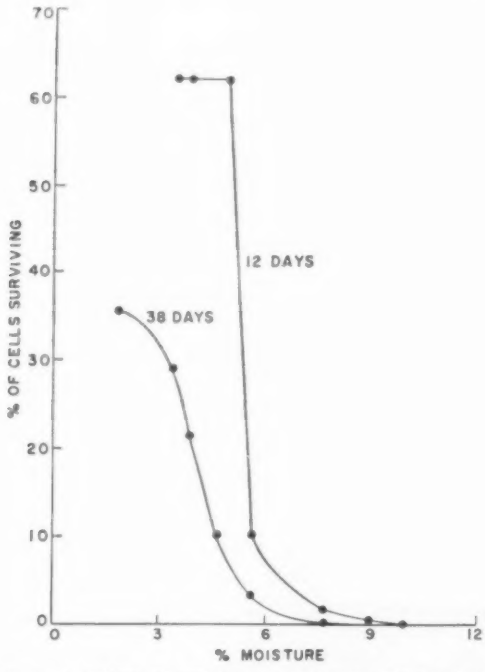


Figure 1. Effect of moisture content upon the survival of cells of S. oranienburg in pan dried albumen stored at 50° C.

Albumens which contained 1.5, 3, 6 or 12% moisture were analyzed for the numbers of *Salmonella (S. pullorum, S. oranienburg* or *S. senftenberg)* that survived storage at 50°, 60° or 70°. The effect of moisture content of the albumen and temperature of storage on the survival of *S. oranienburg* can be observed in Figure 2.

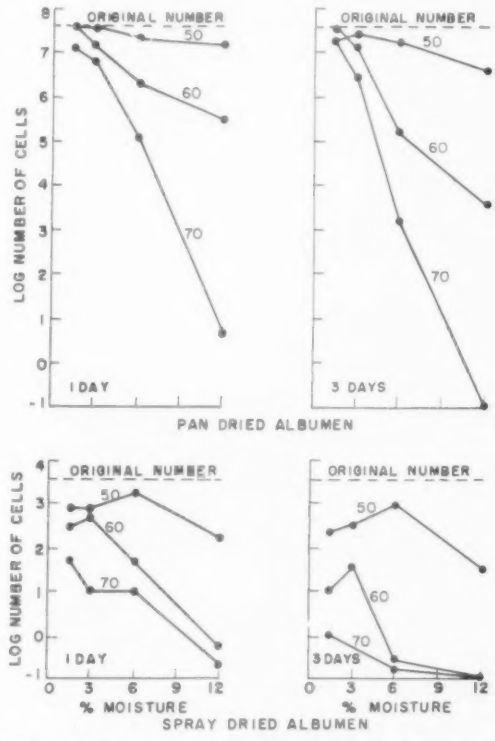


Figure 2. Numbers of S. oranienburg detected in pan dried and in spray dried albumens containing 1.5, 3, 6 or 12% moisture and stored at 50°, 60° or 70° C. for 1 and 3 days.

Similar results were obtained with either *S. senftenberg* or *S. pullorum*. Fewer organisms were observed in albumens containing 12% moisture than from those powders with 1.5, 3 or 6% moisture. In all trials except one, fewer viable organisms were found in albumen containing 6% moisture than in those albumens with either 1.5 or 3%. Comparison of the survivors of *Salmonella* in albumens possessing 1.5 or 3% moisture indicated that, in 11 of 36 conditions, there were more survivors in those samples with 3% moisture. These results agree

with those shown in Figure 1 where, in general, there was no apparent difference between the percent of survivors in albumen having 1.5 or 3% moisture; however, as the moisture content of the powder increased, the percent of survivors was greatly reduced.

As the temperature of storage was increased, the number of viable cells of *Salmonella* isolated after storage was decreased. In every case there were fewer survivors of *Salmonella* in the albumen stored at 70° C. than in that stored at 60° or 50° C.

Effect of moisture on initial rate of death. The initial death rates for the organisms stored in albumen at each of the 4 levels of moisture are plotted in Figure 3. Statistical analysis revealed that moisture

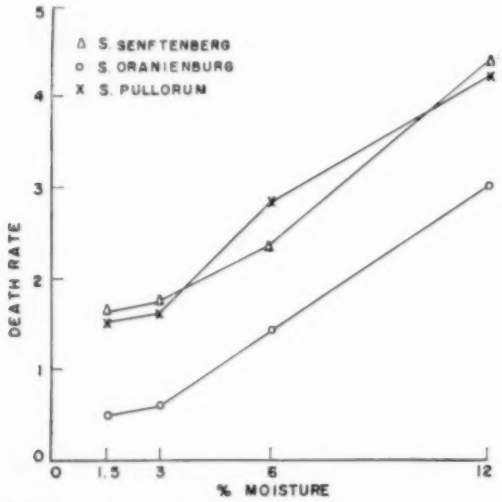


Figure 3. Effect of moisture content on the rate of death of three species of Salmonella in dried albumen stored at elevated temperatures (50°, 60° and 70° C.).

content of the albumen caused a significant difference ($P = .01$) in the initial rate of death of *Salmonella*; however no difference was observable between 1.5 or 3% moisture; nearly all the difference existed among the initial death rates of *Salmonella* in powders containing 3, 6 and 12% moisture. A steady increase in the rate of death was observed from 3 to 12% moisture.

Effect of temperature of storage. The initial death rates for *S. senftenberg*, *S. oranienburg* and *S. pullorum* were averaged at each of the storage temperatures (50°, 60° or 70° C.) and plotted in Figure 4. The curves in this figure approximate straight lines, indicating that a direct relationship exists between temperature of storage and the rate of death. The rates of death were found to be significantly different ($P = .01$) at the three temperatures of storage.

Effect of type of dried product. The initial death rates of the three species of *Salmonella* both in spray and in pan dried albumens are shown in Figure 5. The rate of destruction of *S. senftenberg* and *S. oranienburg* was greater in spray dried than in pan dried albumen. Shearing of the droplets of egg white during atomization and exposure to high temperatures (80° to 140° C.) during the spray drying operation could account for the more rapid reduction of cells in spray dried than in pan dried albumens.

Species of Salmonella. In spray dried albumen the initial rate of death of *S. pullorum* was similar to that of *S. senftenberg*, while that of *S. oranienburg* was significantly less ($P = .01$). Thus, in order to determine storage conditions needed to eliminate *Salmonella*, consideration must be given to the organisms that may be present in the dried albumen.

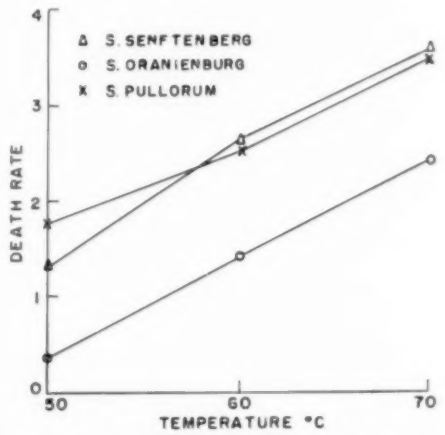


Figure 4. Effect of temperature of storage on the death rate of three species of Salmonella in dried albumen.

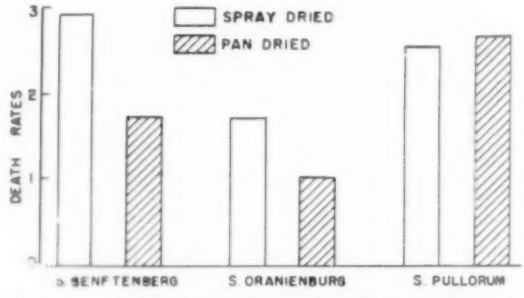


Figure 5. Average death rates of S. senftenberg, S. oranienburg, S. pullorum in pan dried or spray dried albumens due to storage at elevated temperatures.

Functional Changes

Solubility. To compensate for the moisture already in the dried product (1.5 to 12%) the solubility values obtained by analysis were adjusted to a per gram solids basis. In general, no serious loss of solubility was observed during storage. Statistical analysis showed that in only three instances did a significant ($P = .01$) reduction in solubility occur at the time periods used for sampling; this was evident in the albumen containing 12% moisture and stored at 70° C. for 1 day or at 60° C. for 6 days and in albumen with 6% moisture stored at 70° C. for 30 days.

Specific gravity of meringue. In only two of the twelve storage conditions was there a significant ($P = .01$) increase in specific gravity of meringue. This

occurred in the case of albumens that contained 12% moisture and were stored at 60° or 70° C. In general, more desirable specific gravity of meringue was obtained with albumens containing 1.5, 3 or 6% moisture after storage at 50° for two months than with the freshly dried product. Also, albumen containing 1.5% moisture and stored at 70° C. gave meringue of lower specific gravity when tested at the end of 1 month than it did initially. Improvements in beating properties during storage were also evident in the data presented by Bergquist *(3)*. Errors and variations incurred in the analysis might be suggested as reasons for an apparent improvement in whipping properties, but the number of times that this occurred indicated that a more likely answer would be that there was a change in the protein structure of the albumen which resulted in observed improvement in specific gravity of meringue.

Angel cakes. The ability of albumen to form a stable foam suitable for making angel cakes is the ultimate criterion for the functional value of this product. The changes in the angel cake-making properties of albumen were more critical than were either solubility or whipping properties; significant losses in angel cake volume were observed for seven of the twelve storage conditions used.

At a storage temperature of 50° C., albumens containing 1.5, 3 or 6% moisture were stored for 150, 120 and 90 days, respectively, without any significant loss in volume of angel cakes, while albumen with 12% moisture showed a significant decrease in volume of the resulting angel cakes at 3 days of storage. Albumen with a moisture content of 1.5% stored at 60° or 70° C. for 120 days and 30 days, respectively, did not show a significant low of angel cake-making properties. A significant loss in volume of resultant angel cakes was observed when albumen containing 12% moisture was stored at 60° or 70° C. for 1 day.

Results of these experiments indicate that moisture content and temperature of storage of albumen are important aspects to be considered in the storage of albumen intended for use in angel cakes.

Effects of Storage on Salmonella and on the Functional Properties of Dried Albumen

High initial counts of 3 species of *Salmonella* (*S. senftenberg*, 317,000 per gram, *S. oranienburg*, 28,000 per gram or *S. pullorum*, 900 per gram) were reduced to less than 0.18 organisms per gram during storage at 50°, 60° or 70° C. However, the functional properties of dried albumen likewise were found to undergo changes when the powder was stored at the three temperatures.

The results obtained when albumen was stored at temperatures of 50°, 60° and 70° C. are summarized in Figures 6, 7, and 8. In these figures the number of days that spray dried albumen was stored with observable changes occurring in the functional properties (solubility, specific gravity of meringue and angel cake volume) are compared with the time required to reduce the number of *S. senftenberg*, *S. oranienburg* or *S. pullorum* to less than 0.18 per gram. Observations of the

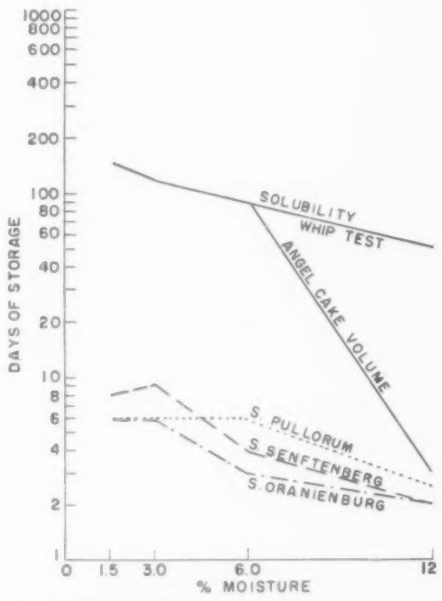


Figure 6. Limiting conditions for storing spray-dried albumen at 50° C.

Areas above the solid line indicate times of storage for each of the moisture levels where there were observable losses in functional properties. Areas above the broken lines indicate time-moisture relationships where populations of the Salmonella species were reduced to less than 0.18 cells per gram.

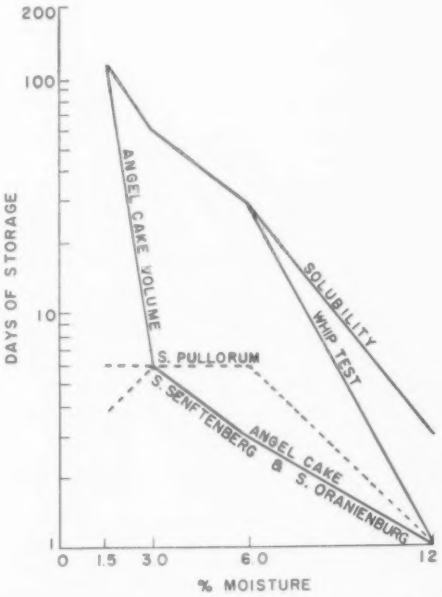


Figure 7. Limiting conditions for storing spray-dried albumen at 60° C.

Areas above the solid line indicate times of storage for each of the moisture levels where there were observable losses in functional properties. Areas above the broken lines indicate time-moisture relationships where populations of the Salmonella species were reduced to less than 0.18 cells per gram.

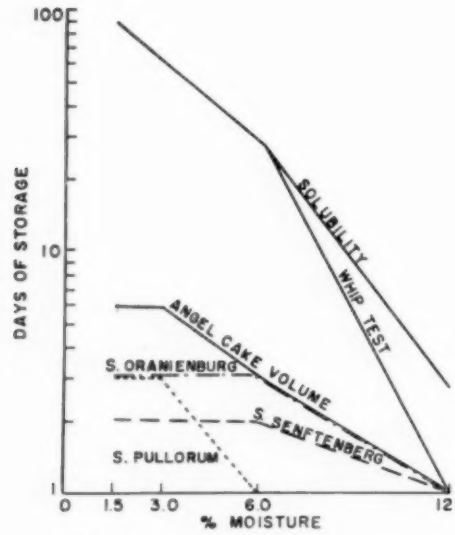


Figure 8. Limiting conditions for storing spray-dried albumen at 70° C.

Areas above the solid line indicate times of storage for each of the moisture levels where there were observable losses in functional properties. Areas above the broken lines indicate time-moisture relationships where populations of the Salmonella species were reduced to less than 0.18 cells per gram.

curves showed that a 50° C., storage of albumen containing any of the four moisture levels effected reduction of the number of *Salmonella* to less than 0.18 per gram before any significant changes occurred in the functional properties of the powder. Storage at 60° or at 70° C. resulted in rapid deterioration of powder containing 12% moisture. If storage temperatures of 60° or 70° C. are to be used, the moisture level of the powder should be maintained below 6%, and, more desirably, below 3%, so that the *Salmonella* are eliminated before the functional properties of the albumen are destroyed.

If the relationship of functional properties to bacterial destruction is compared at 50°, 60° and 70° C., there is a much larger zone of safety at 50° C. than at either 60° or 70° C. By the time that viable cells were no longer detectable at 60° or 70° C., there were noticeable losses in volume of angel cakes. On the other hand, at 50° C. all three of the species of *Salmonella* tested were reduced to levels of less than 0.18 cells per gram in 9 days at 3%, or 6 days at 6% moisture, while no changes in functional properties were observed for at least 120 days at 3%, or 90 days at 6% moisture.

SUMMARY

As the temperature of storage is increased from 50° C. to 70° C., the initial rate of death of *Salmonella* is increased proportionally. In general, as the moisture content of the albumen is increased, the initial death rate of *Salmonella* is increased. Evidently, there is no difference in the initial rate of death of *Salmonella* in albumen containing either 1.5 or 3% moisture.

Under the conditions of this study *S. oranienburg* is more resistant to destruction during storage of dried albumen than are either *S. senftenberg* or *S. pullorum*.

It is possible to store dried albumen containing 1.5, 3 or 6% moisture at 50° C. or albumen containing 1.5 or 3% moisture at 60° or 70° C. and eliminate large numbers of *Salmonella* without significant impairment of functional properties, including angel cake-making properties. High initial counts of *Salmonella* can be eliminated in dried albumen containing 1.5, 3 or 6% moisture and stored at 50°, 60° or 70° C. without noticeably affecting either specific gravity of meringue or solubility. With those albumens containing 1.5, 3 or 6% moisture, an improvement was noted in specific gravity of meringue during storage at either 50° or 60° C.

Acknowledgment

The authors gratefully acknowledge the technical assistance of Mrs. Betty Wymore, who prepared many of the angel cakes. Also, we wish to thank Dr. Frances Carlin and Dr. Hans Lineweaver for their valuable suggestions. In addition, we are indebted to Armour & Company, Chicago and to Henningsen, Inc., Springfield, Mo. for their help, use of facilities, and their many kindnesses throughout the period of this investigation.

LITERATURE CITED

1. Association of Official Agricultural Chemists. *Official Methods of Analysis.* 1950. 7th ed., p. 342.
2. Ayres, J. C., and Slosberg, H. H. Destruction of *Salmonella* in egg albumen. *Food Technol.*, **3**, 180 (1949).
3. Bergquist, D. H. Functional properties of egg white as influenced by atomization and drying. (Ph.D. thesis, Iowa State College, Ames, Iowa, 1951).
4. Bollenback, C. H. Removal of glucose from egg albumen by a controlled fermentation. (Ph.D. thesis, Iowa State College, Ames, Ia., 1949).
5. Bornstein, S., Saphra, I., and Strauss, L. Frequency of occurrence of *Salmonella* species. *J. Infectious Diseases*, **69**, 59 (1941).
6. Browne, A. S. The public health significance of *Salmonella* on poultry and poultry products. (Ph.D. thesis, University of California, Berkeley, Calif., 1949).
7. Carlin, A. F., and Ayres, J. C. Storage studies on yeast-fermented dried egg white. *Food Technol.*, **5**, 172 (1951).
8. Carlin, A. F., and Ayres, J. C. Effect of the removal of glucose by enzyme treatment on the whipping properties of dried albumen. *Food Technol.*, **7**, 268 (1953).
9. Edwards, P. R., Bruner, D. W., and Moran, A. B. The genus *Salmonella*. Its occurrence and distribution in the United States. Kentucky Agr. Expt. Sta. *Bull. 525* (1948).
10. Gibbons, N. E., Fulton, C. O., and Reid, M. Dried whole egg powder. XXI. Pasteurization of liquid egg and its effect on quality of the powder. *Can. J. Research*, sect. F, **24**, 327 (1946).
11. Gibbons, N. E., and Moore, H. L. Dried whole egg powder. XII. The effect of drying, storage and cooking on the *Salmonella* content. *Can. J. Research*, sect. F, **22**, 58 (1944).
12. Goresline, H. E., Hayes, K. H., Moser, R. E., Howe, M. A., and Drewniak, E. E. Pasteurization of liquid whole egg under commercial conditions to eliminate *Salmonella*. U. S. Dept. Agr. *Circ. 897* (1951).
13. Goresline, H. E., Stuart, L. S., Smart, H. F., and Dawson, V. T. Effect of storage temperature on bacterial counts in spray-dried whole egg powder. *J. Bact.*, **45**, 48 (1943).
14. Hartsell, S. E. Studies on the bacteriology of stored dried egg powder. *Food Research*, **9**, 505 (1944).
15. Hinshaw, W. H., and McNeil, E. *Salmonella* infection as a food industry problem. In *Advances in Food Research*,

ed. E. M. Mrak and G. F. Stewart, 3, 209, 1951, Academic Press, Inc., New York, N. Y.

16. Hirschmann, D. J., and Lightbody, H. D. Effect of bacteria on quality of stored lyophilized egg powder. *Food Research*, 12, 381 (1947).
17. Johns, C. K. Microbiological aspects of egg powder. *Sci. Agr.*, 24, 373 (1944).
18. Kline, R. M. Dried egg albumen. I. Studies of the non-microbiological changes during storage. (Ph.D. Thesis, Iowa State College, Ames, Ia., 1945).
19. McFarlane, V. H., and Calesnick, E. J. Notes on the microbiology of army low-moisture egg powder. *Poultry Sci.*, 27, 87 (1948).
20. McFarlane, V. H., Watson, A. J., and Goresline, H. E. Microbiological control in the production of spray-dried whole egg powder. *U. S. Egg and Poultry Mag.*, 51, 250 (1945).
21. Maurer, O. Bacteriological studies on eggs. Kansas Agr. Expt. Sta. *Bull. 180* (1911).
22. Moran, T. The storage of eggs. Rept. of Gt. Brit. Sci. and Ind. Res. Dept. Food Invest. Bd., 1934, 61 (1934).
23. Moran, T. Gas storage of eggs. *J. Soc. Chem. Ind.*, 56, 96T (1937).
24. Moran, T. Gas storage of meat and eggs. *Food Research*, 3, 149 (1938).
25. Osborne, W. W., Straka, R. P., and Lineweaver, H. Heat resistance of strains of *Salmonella* in liquid whole egg, egg yolk and egg white. *Food Research*, 19, 451 (1954).
26. Seligmann, E., Saphra, I., and Wassermann, M. *Salmonella* infections in man. An analysis of 1,000 cases bacteriologically identified by the New York *Salmonella* center. *Am. J. Hyg.*, 38, 226 (1943).
27. Slosberg, H. M., Hanson, H. L., Stewart, G. F., and Lowe, B. Factors influencing the effect of heat treatment on the leavening power of egg white. *Poultry Sci.*, 27, 294 (1948).
28. Stiles, G. W., and Bates, S. L. A bacteriological study of shell, frozen, and desiccated eggs. U. S. Dept. of Agr. *Bull. 158* (1912).
29. Stuart, L. S., Grewe, E., and Dicks, E. R. Solubility of spray-dried whole egg powder. *U. S. Egg and Poultry Mag.*, 48, 498 (1942).
30. Sutton, R. H., and McFarlane, V. H. Microbiology of spray dried whole egg. III. *Escherichia coli*. *Food Research*, 12, 474 (1947).
31. Wilkin, H., and Winter, A. R. Pasteurization of egg yolk and white. *Poultry Sci.*, 26, 136 (1947).
32. Wilson, M. R. Survival of *Salmonella* organisms in stored egg powder. *Food Inds.*, 20, 873 (1948).
33. Winter, A. R., Stewart, G. F., McFarlane, V. H., and Solowey, M. Pasteurization of liquid-egg products. III. Destruction of *Salmonella* in liquid whole egg. *Am. J. Public Health*, 36, 451 (1946).

Volatile Flavor of Strawberry Essence. I. Identification of the Carbonyls and Certain Low Boiling Subtances

K. P. DIMICK and BENJAMIN MAKOWER

Western Utilization Research Branch, Agricultural Research Service, United States Department of Agriculture, Albany 10, California

(Manuscript received September 18, 1955)

In aqueous distillates of Marshall strawberry puree, acetaldehyde, acetone, 2-hexenal, biacetyl, methanol, ethanol, and esters containing acetic and n-butyric acids were identified. An oil fraction separated by further distillation of the aqueous essence amounted to about 13% of the total essence and was about one-third free fatty acids: n-caproic, n-valeric, n-butyric, isobutyric, and acetic. The fatty-acid-free oil fraction seemed to contain all of the characteristic strawberry aroma. The amount of carbonyls and the total amount of essence as measured by carbon analysis were not correlated with the flavor potency of the essence, as judged by a taste panel.

A systematic study of the identities and amounts of the volatile flavoring compounds in strawberries is being made at the Western Utilization Research Branch. The purpose is to determine why some varieties of strawberries have more flavor than others. The method consists of identification and measurement of the volatile chemical compounds responsible for the quality, quantity, and potency of flavor. From this knowledge an objective chemical test may be developed for assaying the flavor potency. The volatile substances from fruit are a mixture of organic compounds varying in their amounts, solubility, and volatility. The low concentration of these volatile substances and the instability of the fruit increase the problems of separation and analysis. These organic substances also vary markedly in their flavor intensity.

Previous work by Coppens and Hoejenbos *(2)*, using an ether extract of 445 kg. of strawberry juice, showed the following compounds to be present: acetic acid, cinnamic acid, *n*-caproic acid, ethanol, biacetyl, ethyl acetate, iso-amyl alcohol, a formic ester, a butyric ester (probably ethyl), a caproic ester (ethyl or methyl), acetic esters, a benzoic ester, n-hexanol, ethyl salicylate, borneol, α-terpineol, terpin, and an unidentified acid and ketone. Other constituents reported as probably present were acetyl methyl carbinol, acetophenone, iso-fenchyl alcohol. McGlumphy *(6)* has confirmed acetophenone, biacetyl, cinnamic acid, and acetic acid. In addition he identified *n*-butyraldehyde, cis-terpinol hydrate, and probably ethyl acetoacetate.

MATERIALS AND METHODS

The 4 major steps in the procedure for this investigation are: (A) preparation of a puree or juice of the fruit, (B) removal

of the flavors from the puree or juice by distillation, (C) concentration of the dilute flavor solutions, and (D) performing appropriate analyses of the various constituents.

The equipment used for separating the volatile flavor from the fruit and for concentrating the essence solutions consists of a continuous laboratory vacuum flash evaporator which will remove 50% of the water from a puree or 70% from a juice in a single pass at about 100° F. (37.8° C.), and an all-glass continuous bubble plate distillation column. This equipment was described in detail elsewhere *(3, 4)*. By means of this distillation column up to 2,000-fold essence solutions have been prepared.[a] Since the volatile constituents are organic, the recovery of essence was followed by means of a total carbon analysis of the various distillates *(1)*. Approximately 80% of the total strawberry volatiles are removed when 40% of the water is stripped from a puree, and practically no loss occurs in the concentration step with the still.

An analysis of the carbonyl content of the different varieties of berries was made on the aqueous concentrate mentioned above by a modification of the methods described by Lappin and Clark *(5)* and Neuberg and Strauss *(7)*. This method depends on the formation of the 2,4-dinitrophenylhydrazone (2,4-DNPH) derivatives of the carbonyl compounds, and the formation of an intense colored complex when potassium hydroxide is added to an alcoholic solution of these derivatives. Monocarbonyl derivatives form a red color, whereas dicarbonyl derivatives, such as biacetyl 2,4-DNPH, form a blue color.

The procedure is as follows: To each ml. of 40-fold essence is added 0.4 ml. of reagent (500 mg. of DNPH reagent in 50 ml. of 40% sulfuric acid) in a glass-stoppered bottle. This mixture is heated for 20 minutes on a steam bath and then cooled for one hour. The precipitated derivatives are then filtered on a "Celite" coated sintered-glass funnel. The filter cake is washed with 2 or 3 ml. of water. The monocarbonyl derivatives which are soluble in alcohol are then washed from the funnel with about 20 ml. of hot alcohol and the filtrate is made up to 25 ml. with alcohol. The dicarbonyl derivatives are then washed from the funnel with a minimum of hot nitrobenzene and the filtrate is made up to 15 ml. with nitrobenzene. Nitrobenzene is the only good solvent known for this type of compound. Aliquots of the two filtrates are made up to 9 ml. with ethanol and one ml. of 2 *N* KOH is added. The intensity of the colors developed are estimated with a Klett-Summerson colorimeter and a 540 mμ (green) filter for the red solutions and a 590 mμ (orange) filter for the blue solutions. The amount of material is estimated from standard curves prepared from stock solutions of acetone and biacetyl 2,4-DNPH derivatives.

For analysis of the individual carbonyls, the alcohol-soluble 2,4-DNPH derivatives were separated with a silicic acid chromatographic column. Petroleum ether (b.p. 60° to 70° C., 140° to 158° F.)–ethyl ether 90/10 was used as the developing solvent. Three bands were separated and the material composing each band was identified as the 2,4-DNPH derivatives of 2-hexenal, acetone, and acetaldehyde. Identification was made on the assumption that with authentic samples there was no lowering of melting point and that ultraviolet absorption spectra and X-ray diffraction patterns were identical. The 2,4-DNPH derivatives of the carbonyls melted as follows: 2-hexenal 293 to 295° F. (145 to 146° C.), acetone 255° F. (124° C.), acetaldehyde 315° F. (157° C.), bis-biacetyl 615° F. (324° C.).

RESULTS AND DISCUSSION

The amounts of total carbonyls, acetone, 2-hexenal, and biacetyl are given in Table 1. The amount of acetaldehyde can be estimated as the difference between the total amount of carbonyls and those listed. There is no correlation between the total or individual carbonyl content of the essence and the flavor intensity.

A striking difference was found in the 2-hexenal content of the essence from frozen and unfrozen whole strawberries (Table 2). This aldehyde, sometimes called "leaf aldehyde," is apparently produced enzymatically by the fruit when pureed, as shown by the fact that either freezing or heating the whole berry will prevent the appearance of this aldehyde in the essence, while heating or freezing the puree from untreated whole berries will not affect the 2-hexenal content. Nye and Spoehr *(8)* have shown this compound to be produced in large amounts in crushed leaves of *Ailanthus glandulosa* (Chinese "tree of heaven"). Heating or crushing the leaves in the absence of oxygen prevented the formation of 2-hexenal. White *(11)* reported its presence in the essence from apple juice. The relative importance of 2-hexenal to the flavor of the fruit is yet to be determined.

TABLE 1

Carbonyl content and flavor intensity of the aqueous essence from various varieties of strawberries, 1948 season

Variety	Carbon	Carbonyls total	P.P.M. in puree			Flavor intensity
			Acetone	Biacetyl	2-hexenal	
Britemore	57	5.65	2.34	.82	trace	455
Sovereign	59	8.47	6.78	.76	trace	472
Marshall	75	2.6	1.56	.51	.038	600
Red Heart	55	19.2	8.55	1.30	trace	880
Corvallis	92	6.75	1.87	.59	trace	1104
President	84	11.9	5.03	1.48	trace	1300
Ettersburg	66	6.1	5.2	1.88	trace	2200

TABLE 2

2-hexenal content p.p.m. in frozen and unfrozen Marshall strawberries

Year	Frozen	Unfrozen
1948	0.038	
1949	0.066	7.2
1950	—	6.1

On the basis of results thus far, neither total essence as measured by carbon analysis nor carbonyl content seemed related to the flavor strength of the berries. Therefore, it became desirable to investigate other chemical components of the essence. Since freezing was shown to cause alterations, fresh Marshall berries were used for a systematic general analysis of the essence.

Eight hundred pounds of strawberries obtained from the State of Washington were cleaned, stemmed, pureed, and processed immediately. The stripped essence from the puree was concentrated 850-fold. Total-carbon and carbonyl analyses were made on a 50-fold essence, since separation of an oil occurred when the concentration reached about 300-fold.

The major portion of the organic volatiles was separated from the 850-fold product by distillation in a fraction which boiled below 190° F. (88° C.). This fraction contained no typical strawberry aroma. The remainder of the essence was collected with a large amount of water in a fraction boiling between 203° and 212° F. (95° and 100° C.). This fraction contained a

[a] The word fold as used here means essentially the extent of concentration. In this example it would take 2,000 g. of puree to make 1 g. of 2,000-fold essence.

[b] Mention of specific products does not constitute endorsement by the Department of Agriculture over others of a similar nature not mentioned.

small amount of a water-insoluble oil and possessed a powerful aroma of strawberries. The organic components of this fraction were separated from the water by an isopentane extraction and appeared as a light-yellow oil after removal of the isopentane.

An over-all analysis of the strawberry essence is shown in Table 3. The amount of essence is shown as parts per million of carbon and is also calculated as ethyl alcohol. The amount of the 4 carbonyl compounds mentioned before—acetaldehyde, acetone, *2*-hexenal, and biacetyl—is shown, and their percentages of total

TABLE 3
Analysis of fresh Marshall strawberries

Description	P.P.M. in original puree	Percent of total essence
Essence (as carbon)	42	100
Essence (as ethanol)	80	100
Acetaldehyde	4.9	6.1
2-Hexenal	7.2	9.0
Acetone	2.7	3.4
Biacetyl	0.21	0.26
Ethanol	45.5	57.0
Methanol	4.7	5.8
Esters (calc. as ethyl acetate)	9.4	11.7
Acids of esters:		
acetic, *n*-butyric		
Water Insoluble Oil	7.5	9.3
Free Fatty Acids	3.00	3.7
n-caproic	1.5	1.9
n-valeric	0.8	1.0
n-butyric isobutyric	0.52	0.7
Acetic	0.12	0.15

essence are listed. Two alcohols, methanol and ethanol, were separated by distillation and measured. They were identified by boiling point and mixed melting point of their 3,5-dinitrobenzoate derivatives, which showed no depression with authentic samples: ethanol 3,5-DNB (m.p. 92° C.) methanol, 3,5-DNB (m.p. 106° C.) As may be seen, ethanol accounts for more than half of the total essence.

The amounts of esters calculated as ethyl acetate were determined by saponification of the low-boiling fraction. Only acetic and *n*-butyric acids were found in this ester group. The organic acids were separated by the chromatographic procedure described by Ramsey and Patterson *(9, 10)* and identified by X-ray diffraction pattern of their crystalline sodium salts. This method of identifying the acids was found to be very satisfactory, provided care was used in drying the samples. All of the sodium salts were dried at *20%* relative humidity and were transferred to the capillaries in a dry box. The iso-acids of butyric, valeric, and caproic were found to crystallize with one molecule of water under these conditions.

The highly flavored oil fraction amounting to about 13% of the total essence was about one-third free fatty acids: *n*-caproic, *n*-valeric, *n*-butyric, isobutyric, and acetic. These acids, in the concentration found in the fruit, cannot be detected by taste in distilled water. The remainder of the oil fraction, although amounting to only about 7.5 p.p.m. in the fruit, has such a powerful flavor intensity that the aroma of strawberry can be clearly recognized in a concentration of 0.1 p.p.m. This is about one-tenth of a gram per ton of fruit. The composition of this oil is presently under investigation.

SUMMARY

Different varieties of strawberries vary in their flavor intensity. The amount of total organic volatiles does not measure the strength of flavor, nor does the carbonyl content seem related to flavor intensity. Freezing or heating the whole fruit reduces the *2*-hexenal content of the essence to a trace. In all the volatile organic compounds called essence we have a major portion (90% or greater) which in themselves are not reminiscent of strawberries. The typical strawberry aroma appears to reside in an oil fraction amounting to about 7% of the total essence. It may turn out, however, that the well-balanced flavor will require the presence of these less aromatic constituents. This will have to be determined after a complete analysis of the oil has been made.

LITERATURE CITED

1. Christensen, B. E., Wong, R., and Facer, F. J. Determination of the carbon content of organic materials. *Ind. Eng. Chem., Anal. Ed.*, **12**, 364 (1940).
2. Coppens, A., and Hoejenbos, L. Volatile constituents of strawberry juice. *Rec. Trav. Chim.*, **58**, 680 (1939).
3. Dimick, K. P., and Makower, B. A laboratory-scale continuous vacuum flash evaporator. *Food Technol.*, **5**, 517 (1951).
4. Dimick, K. P., and Simone, M. J. A laboratory continuous distillation column for concentration of aqueous solutions of volatile flavors. *Ind. Eng. Chem.*, **44**, 2487 (1952).
5. Lappin, G. R., and Clark, L. C. Colorimetric method for determination of traces of carbonyl compounds. *Anal. Chem.*, **23**, 541 (1951).
6. McGlumphy, J. H. Fruit flavors. *Food Technol.*, **5**, 353 (1951).
7. Neuberg, C., and Strauss, E. Microdetermination of dicarbonyl compounds on the coloring of nitro compounds in alkaline solutions. *Arch. Biochem.*, **7**, 211 (1945).
8. Nye, W., and Spehr, H. A. The isolation of hexenal from leaves. *Arch. Biochem.*, **2**, 23 (1943).
9. Ramsey, L. L., and Patterson, W. I. Separation and identification of the volatile saturated fatty acids (C_1—C_4). *J. Assoc. Offic. Agr. Chem.*, **28**, 644 (1945).
10. Ramsey, L. L., and Patterson, W. I. Separation and determination of the straight-chain saturated fatty acids C_5 to C_{10} by partition chromatography. *J. Assoc. Offic. Agr. Chem.*, **31**, 139 (1948).
11. White, J. W., Jr. Composition of a volatile fraction of apples. *Food Research*, **15** (1), 68 (1950).

Moisture Distribution in Fresh, Frozen, and Frozen-Defrosted Bread

J. W. PENCE, N. N. STANDRIDGE, D. K. MECHAM, T. M. LUBISICH, AND H. S. OLCOTT

Western Utilization Research Branch, Agricultural Research Service, United States Department of Agriculture, Albany 10, California

(Manuscript received September 26, 1955)

Frozen and frozen-and-defrosted bread essentially retained the moisture distribution of freshly baked, unfrozen bread for at least 7 weeks of storage at 0° F. (—18° C.) and 20° F. (—7° C.). A slight but statistically nonsignificant (at the 5% level) increase in crust and intermediate crumb moisture occurred during freezing of round-top bread. On the same basis a significant difference in moisture distribution between freshly baked round-top and sandwich bread was found only in the crust region.

Among factors that conceivably might affect the successful preservation of bread freshness by freezing is the possibility of important changes in normal moisture distribution caused by freezing, defrosting, or storage in normally dry, refrigerated spaces. A previous report from this Laboratory *(8)* indicated that a serious loss of total moisture can occur in unwrapped frozen bread during storage, but general experience in the baking industry indicates that conventional wrapping materials adequately guard against moisture losses, provided the wrappers remain sealed and intact.

Several authors *(4, 6, 7, 10)* have pointed out that most of the moisture loss from bread is from the crust and the outer half-inch of crumb. Immediately after baking, the crust is relatively dry, but it rapidly begins to absorb moisture from adjacent crumb. Bice and Geddes *(4)* measured the moisture distribution in freshly baked bread (150 g. pup doughs) and after storage up to 15 days under conditions which prevented a loss of total moisture. They reported that moisture content of the crust increased from 15.4% to 27.3% after 6 days of storage. The central crumb and the crumb within 0.5 inch of the crust had the same moisture content immediately after baking, but the moisture content of outer crumb dropped from 44.9% to 32.3% in 6 days while that of inner crumb decreased from 45.1% to 37.0% in the same period. Subsequent work by Bradley and Thompson *(5)* and others *(2, 3)* confirmed these findings, in general, with larger loaves baked from a commercial-type formula, although the magnitude of migration of moisture from crumb to crust was much less than that reported by Bice and Geddes *(4)*. The former workers *(5)* also showed that the moisture content of crumb stored without crust remained constant for at least six days.

Bechtel and Meisner *(3)* showed that migration of moisture from crumb to crust of bread during storage can account for an important part of the staling changes which occur in the period from 20 to 140 hours after bread is baked. A difference of 2% in crumb moisture was sufficient to cause a statistically significant difference (at the 5% level or below) in human judgment of the freshness of bread. Earlier, however, Bradley and Thompson *(5)* and Bechtel, Meisner, and Bradley *(2)* had shown that moisture migration had no appreciable effect on crumbliness and crumb compressibility measurements during a 6-day storage period and that these physical measurements did not agree with sensory measurements of staling. In bread, both with and without crust, these measurements decreased considerably and in about equal amounts during the first two days of storage, whereas sensory measurements showed little decrease in freshness. After the second day of storage, physical measurements continued to decrease slowly and, again, about equally in both breads. Sensory measurements, however, showed that bread without crust retained much apparent freshness for the remaining 4 days of storage, while bread with crust became appreciably stale.

Because moisture differences are thus related to sensory perception of staleness and because freezing and defrosting may alter the distribution of moisture in bread,* a comparison was made of the normal moisture distribution in freshly baked bread with that in frozen and in frozen-and-defrosted bread. The following results indicate that frozen and frozen-and-defrosted bread essentially retained the moisture distribution of freshly baked bread and that a fluctuating storage temperature caused no important movement of moisture within frozen bread.

MATERIALS AND METHODS

The breads used were large (22.5 oz.) round-top and sandwich loaves obtained from either of two commercial bakeries about 2 hours after baking. Freezing and storage procedures were the same as described elsewhere *(8, 9)* unless otherwise indicated. Moisture was determined by first allowing bread to become air-dry at room temperature; then the samples were ground and dehydration was completed on sub-samples by the A.A.C.C. method *(1)*.

RESULTS AND DISCUSSION

Moisture distribution in unfrozen braed. To obtain an understanding of moisture distribution in fresh bread, loaves of commercially sliced sandwich bread containing 28 slices were subdivided into 4 portions as follows: (a) the 2 heel slices, (b) the 4 slices adjacent to each heel (the end group E), (c) the next 4 slices from each end (intermediate group M), and (d) the 10 remaining slices (central group S). The groups then contained 2, 8, 8, and 10 slices, respectively. Next, the latter 3 groups were each cut into 3 sections: (a) the

* Suggested by Dr. W. B. Bradley, American Institute of Baking, Chicago.

center crumb (section A), a 1¾-inch square; (b) intermediate crumb (section B), a half-inch band of crumb adjacent to section A; and (c) the crust (section C), containing also the outer crumb about ⅝-inch in width.

TABLE 1

Moisture distribution in wrapped sandwich bread

(Legend: E, M, and S are end, intermediate, and central slice groups, respectively; A, B, and C are center, intermediate, and crust crumb sections, respectively. H, heels.)

Age (hr.)	% H_2O[1]										Total
	EA	MA	SA	EB	MB	SB	EC	MC	SC	H	
5	43.6	43.7	43.6	43.7	43.9	43.8	33.4	32.9	32.7	30.3	36.6
24	43.7	43.6	43.6	42.5	42.8	42.4	32.5	33.3	32.7	31.5	36.4
72	41.9	43.3	43.2	40.1	40.4	40.5	33.5	33.8	33.7	32.8	35.8[2]

[1] Minimum significant difference at 5% level = 2.3%.
[2] After 48 hours.

Moisture determinations were then made on all 10 parts of 5-, 24-, and 72-hour-old loaves (in triplicate) stored at room temperature in the usual waxed-paper wrapper. Total moisture was also measured on separate loaves. The results are tabulated in Table 1 and shown graphically in Figures 1 and 2.

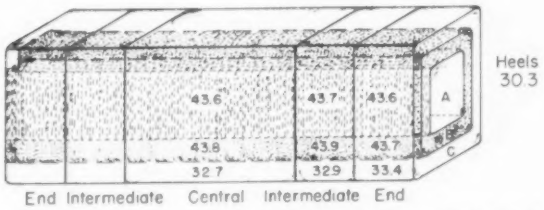


Figure 1. Diagram illustrating subdivision of sandwich loaf into designated slice groups and sections.

Nearly all of the moisture migration was outward from the B section of the slices (second half-inch layer of crumb inward from the crust) during the 3-day storage period. Moisture content of the center core was constant except for slices near the ends of the loaves (group E). Here, with a greater area of dry adjacent crust in the heels, a greater net transfer of moisture

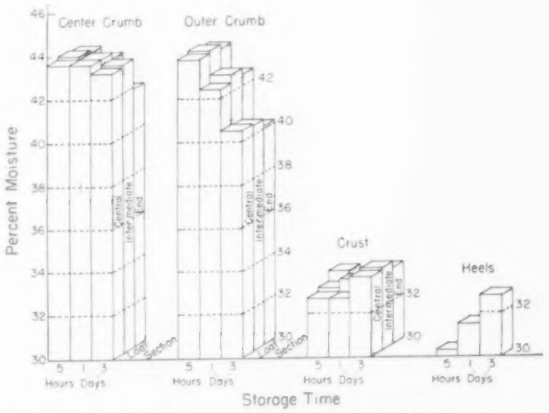


Figure 2. Graphic representation of changes in moisture distribution in sandwich bread during storage at room temperature.

would be expected. The heels gained a greater percentage of moisture than did the crust section (C), but the larger mass of the latter section compensated for the smaller percentage uptake of moisture. Total moisture of other loaves from the same lot of bread remained constant during the experiment. The latter observation was verified in a second experiment in which only center crumb (section A) and total loaf moisture were determined. Both remained constant for the 72-hour test period. (The wrappers on these loaves lost 3 to 4 g. of moisture in the first 24 hours but practically none thereafter; this amounts to about 20% of the wrapper weight and about 0.5% of the loaf weight.)

More detailed results obtained with round-top bread were quite similar to those for sandwich bread except for small differences in crust sections of the former. The end group of 8 slices consisted of 4 slices from each end of a loaf after removal of the heel and the first full slice, and the central group contained 8 slices from the centers of the loaves. A modified pattern of sectioning the slices of round-top bread was used to determine the effect baking in open pans might have on moisture distribution

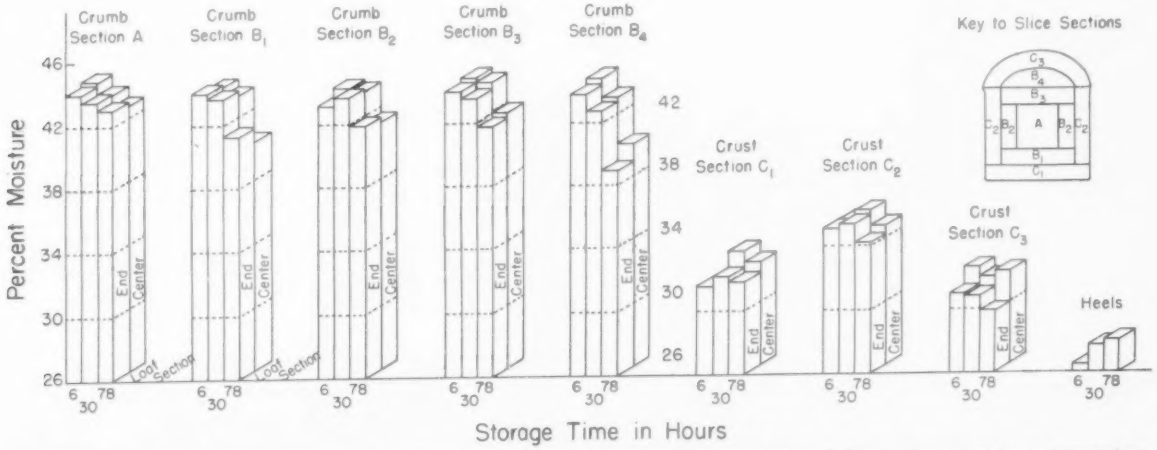


Figure 3. Graphic representation of changes in moisture distribution in round-top bread during storage at room temperature. Inset illustrates method of sectioning slices.

within loaves. A diagram showing how individual slices were sectioned is included in Figure 3, along with a graphic representation of moisture results listed in Table 2.

TABLE 2

Moisture distribution in wrapped round-top bread (Results expressed as percent moisture)[1]

Slice section	Age of bread in hours		
	6	30	78
	End slice group		
A	44.0	43.5	43.0
B_1	43.8	43.3	40.4
B_2	43.2	43.7	41.9
B_3	44.0	43.6	41.8
B_4	43.8	42.7	39.0
C_1	31.6	32.2	31.9
C_2	35.2	35.5	34.3
C_3	31.0	30.9	29.9
	Central slice group		
A	44.2	43.4	42.7
B_1	44.0	43.7	41.3
B_2	43.7	43.5	41.6
B_3	44.3	44.0	42.1
B_4	44.2	43.0	40.1
C_1	31.2	33.2	32.5
C_2	35.2	35.7	34.8
C_3	32.1	31.5	31.9
Heels	26.6	27.8	28.1

[1] Minimum significant difference at 5% level = 0.9%.

The distribution of moisture was quite uniform in the central core (A) and surrounding intermediate portion (B sections) of crumb at the start of the experiment, but crust sections (C) showed some nonuniformity in moisture distribution. The top (C_3) and bottom (C_1) crust sections were of equal moisture content, but the side sections of crust (C_2) were substantially higher throughout the experiment. As the side crust on pan bread is also usually the thinnest and lightest in color, a relation is suggested to the fact that the main source of heat during baking is applied to the bottom of the pan. Radiant heat in the oven is most intense at the bottom of the pan and would tend to drive moisture upwards through the loaf or along its sides. The top crust, being exposed to air, dries rapidly and browns quickly even though heat might be less efficiently applied.

Moisture determinations for corresponding crust sections in freshly baked sandwich bread indicated that the top crust was drier than either side crust or bottom crust and that there was no difference in moisture content between bottom-crust and side-crust sections. The values obtained were 34.5, 34.4, and 31.3% moisture for bottom, side, and top crust sections, respectively.

In contrast to results with sandwich bread, the small decreases in center crumb (A) moisture for round-top bread (Table 2) during the test period were statistically significant. The losses of moisture from the intermediate and center crumb portions of the loaves were not matched by corresponding increases in the crust regions, although a tendency in that direction is evident. The uppermost section of intermediate crum (B_1) lost the most moisture in both slice groups, but no effect occurred in the adjacent crust section (C_3). It is possible that total moisture of the loaves decreased in this experiment, although the determination was not made for this lot of bread. Such moisture would be lost from crust areas and could account for the more or less constant values for crust moisture during this particular experiment. In a separate experiment with a second lot of bread, total loaf moisture decreased from 37.3 to 36.0% in 72 hours, but center-crumb (section A) moisture did not decrease proportionately (44.0 to 43.9%). The latter result is contrary to the preceding experiment with round-top bread but agrees with the two experiments conducted on sandwich bread.

These results with 22.5-oz. loaves agree well with those of Bradley and coworkers (*2, 3, 5*) with 1-lb. loaves in that movement of moisture from crumb to crust was much less than reported by Bice and Geddes (*1*) for smaller loaves. In only one of four determinations, however, did center crumb moisture decrease to an important extent. Moisture content and distribution seem to be slightly more stable in sandwich bread than in round-top bread on the basis of these experiments. Although a nearly 10% gradient in moisture exists in fresh bread between C and B sections (first and second half-inch layers of crumb inward from the crust), migration outward is surprisingly slow.

Moisture distribution in frozen bread. Moisture distribution in round-top bread, frozen in 90 minutes at 0° F., was determined as with fresh bread except that the loaf was not divided into groups of slices. Rather, 10 slices from the center of each of 3 frozen loaves were sectioned into center crumb (A), outer crumb (B), and crust (C), as before. Sections of frozen bread were placed quickly in moistureproof cellophane bags immediately after cutting to avoid condensation of atmospheric moisture before the cold samples could be weighed. As a further precaution, several samples were cut and weighed in the cold room itself, but no difference in the values obtained was thus found. Effects of storage on moisture distribution in frozen bread are shown in Table 3.

TABLE 3

Moisture distribution in frozen and wrapped round-top bread stored at 0° F. (A, B, and C sections are center, intermediate, and crust zones of the slices. Values are expressed as percent moisture)[1]

Slice section	Unfrozen control	Days of storage of frozen bread				
		1.5	7	14	28	49
A	43.8	43.5	43.5	43.3	43.4	43.0
B	42.2	43.7	43.3	43.5	43.1	42.6
C	33.7	35.8	34.7	34.6	33.7	33.1

[1] Minimum significant difference at 5% level = 1.8% moisture.

The moisture distribution in frozen bread remained essentially like that of freshly baked bread throughout 7 weeks of storage. Moisture contents of the B and C sections of freshly frozen slices were slightly higher than in unfrozen bread, and only the crust section (C) showed any tendency to dry out. No measurements were made of total moisture during the storage period, but the small loss from crust sections indicates that any net loss would be small. Maximum uptake and subsequent loss of moisture in the entire crust and outer crumb samples from the 10 slices fell within a range of 5 g.

Moisture distribution in frozen-and-defrosted bread. Moisture distribution in frozen-and-defrosted bread was determined with bread from the same lot as used in the

preceding section. The experimental procedure was similar except that bread was defrosted at room temperature for 5 hours before sampling. Part of the bread in this experiment was stored at a stable temperature of 0° F. (−18° C.) and another part at a temperature that fluctuated between 0° and 20° F. (−18° and −7° C.) on a 24-hr. cycle. Results are shown in Table 4.

TABLE 4

Moisture distribution in frozen-defrosted wrapped, round-top bread stored at a stable temperature of 0° F. or a fluctuating temperature of 0° to 20° F. (A, B, and C sections are center, intermediate, and crust zones of the slices. Values are expressed at per cent moisture)[1]

Slice section	Unfrozen control	Days of storage of frozen bread			
		1.3	7	14	28	49
		Stable temperature				
A	43.8	44.1		43.9	43.9	43.6
B	42.2	44.3		44.2	44.2	43.8
C	33.7	34.5		34.4	34.4	35.0
		Fluctuating temperature				
A	43.8		43.9	43.7	43.8	43.7
B	42.2		44.4	44.1	44.2	43.8
C	33.7		34.9	34.6	33.1	31.2

[1] Minimum significant difference at 5% level = 1.8% moisture.

Moisture distributions were almost identical in bread stored at the stable and the fluctuating temperatures. The crust section (C) of bread stored at the fluctuating temperature only showed appreciable drying out after 4 weeks of storage. As with frozen bread, frozen-and-defrosted bread had a moisture distribution essentially like that of freshly baked bread.

While there were statistically significant differences in moisture distribution between frozen-and-defrosted and frozen bread only in the crust sections after 7 weeks of storage (Table 2), there was also a tendency for outer crumb (section B) moisture to be higher in defrosted loaves than in frozen loaves. It was significantly higher in frozen-and-defrosted than in fresh, unfrozen loaves, however, up to the fourth week of storage.

Effect of rate of freezing and defrosting. Measurements of center crumb (section A) moisture only on loaves frozen or defrosted at different rates showed no statistically significant differences (at the 5% level) due to the treatments. This was not unexpected, even with relatively long freezing or defrosting times, such as 10 to 11 hours, in view of the slow rate of moisture transfer found at room temperature under a 10% gradient in moisture (Table 1). Freezing times used were 0.5, 3, and 7 hours; defrosting times were 2.3, 5.5, and 10.8 hours.

Effect of high-frequency defrosting. Application of high-frequency or microwave heating to frozen bread will cause inner regions of the loaf to thaw and become warm at about the same, very rapid rate as in crust regions. The possibility occurs that such rapid internal heating might alter the distribution of moisture in bread defrosted in this manner. Measurement of moisture in the 3 principal slice sections (described above) of bread defrosted by heating 2½ minutes with about 0.75 kw. of microwave energy, however, showed the distribution of moisture to be unaffected by this type of heating.

SUMMARY AND CONCLUSIONS

In agreement with findings of previous workers, moisture in freshly baked bread was found to move outward from the intermediate crumb to the crust during a 3-day storage period. Moisture of the central core of crumb decreased very slowly despite a 10% gradient in moisture between the crust and center crumb.

The moisture distribution in frozen freshly baked bread remained essentially like that of unfrozen freshly baked bread for at least 7 weeks of storage at 0° F. A very slight increase in moisture occurred in the crust and outer inch of crumb as a result of freezing, but this moisture gradually disappeared during storage.

The distribution of moisture in frozen-and-defrosted bread was likewise essentially like that of unfrozen, freshly baked bread except for a very slight increase in crust and outer crumb moisture as a result of freezing. No change occurred in the moisture distribution of bread stored at 0° F. for 7 weeks before defrosting; but, at a storage temperature fluctuating between 0° and 20° F., a small but statistically significant drying of the crust region occurred.

Rate of freezing or defrosting had no important effect on moisture content of the center crumb of unsliced bread. Microwave defrosting likewise caused no change in the moisture distribution of frozen bread.

Acknowledgments

The cooperation of the Fairfax Bread Company, San Francisco, Calif., and the Berkeley, Calif., plant of the Continental Baking Company was very helpful in obtaining the necessary freshly baked bread for these studies. The assistance of Mrs. Pearl V. Gilmore and Mr. Henry Wright with the moisture determinations is also gratefully acknowledged.

LITERATURE CITED

1. American Association of Cereal Chemists. *Cereal Laboratory Methods*. 1947, 5th Ed. Am. Assoc. Cereal Chemists, St. Paul, Minn.
2. Bechtel, W. G., Meisner, D. F., and Bradley, W. B. The effect of crust on the staling of bread. *Cereal Chem.*, **30**, 160 (1953).
3. Bechtel, W. G., and Meisner, D. F. Staling studies made with flour fractions. III. Effect of crumb moisture and of tailings starch. *Cereal Chem.*, **31**, 176 (1954).
4. Bice, C. W., and Geddes, W. F. Studies on bread staling. IV. Evaluation of methods for the measurement of changes which occur during bread staling. *Cereal Chem.*, **26**, 440 (1949).
5. Bradley, W. B., and Thompson, J. B. The effect of crust on changes in crumbliness and compressibility of bread crumb during staling. *Cereal Chem.*, **27**, 331 (1950).
6. Ford, W. P. The staling of bread. *Arkady Review*, **3**, 5, 85, 100 (1926).
7. Martin, G. W. Salcable bread. *Food*, **13**, 129 (1944), cf. *Chem. Abs.*, **38**, 4045 (1944).
8. Pence, J. W., Lubisich, T. M., Mecham, D. K., and Smith, G. S. Effects of temperature and air velocity on rate of freezing of commercial bread. *Food Technol.*, **9**, 342 (1955).
9. Pence, J. W., Standridge, N. N., Lubisich, T. M., Mecham, D. K., and Olcott, H. S. Studies on the preservation of bread by freezing. *Food Technol.*, **9**, 495 (1955).
10. Whymper, R. Conditions that govern staleness in bread. *Sci. Am. Mo.*, **1**, 96 (1920).

Post Mortem Changes in Meat and Their Possible Relation to Tenderness Together with Some Comparisons of Meat from Heifers, Bulls, Steers, and Diethylstilbestrol Treated Bulls and Steers

EUGEN WIERBICKI, L. E. KUNKLE, V. R. CAHILL, AND F. E. DEATHERAGE

Departments of Agricultural Biochemistry and Animal Science, Institute of Nutrition and Food Technology, the Ohio State University, and the Ohio Agricultural Experiment Station, Columbus, Ohio

(Manuscript received August 1, 1955)

Post mortem changes in tenderness and biochemical properties of meat have been studied using carcasses from heifers, bulls, steers, bulls and steers treated with diethylstilbestrol which had all been fed in a comparable way. Certain effects of hormone treatment are reported. Evidence is presented which indicates that tenderness may be related to the degree of hydration of meat proteins and that post mortem tenderization may be due to certain ion-protein or protein-protein interactions rather than classical proteolysis or dissociation of actomyosin.

The work reported here follows directly from an earlier paper from this laboratory *(18)*. In this previous report a number of post mortem changes in meat were observed which led to the suggestions that post mortem tenderization may be related to dissociation of actomyosin and/or that a redistribution of ions takes place in muscle (meat) on aging in such a way as to cause increased hydration of protein and hence improved tenderness. A detailed biochemical study has been carried out on a number of carcasses so that the suggested hypotheses might be tested more fully.

The data reported here substantiate the statement in the earlier paper that no large amount of proteolysis seems to be taking place during the aging. Sufficient data obtained by improved methods point in the direction that actomyosin is not dissociated on post mortem aging although the amount of actomyosin seems to be related to tenderness. It has also been found that the toughening of meat associated with the onset of rigor mortis is due to the formation of actomyosin. At the same time much of the evidence indicated that post mortem tenderization may be related to changes in the protein systems of muscle in such a way as to cause increased hydration.

The test cattle in the 1954 report *(18)* came to slaughter before the details of the method for extracting meat to separate actomyosin from other proteins had been adequately worked out. Therefore, in that study the extraction procedure as reported was used without change although there were indications that the method was somewhat inadequate. To test the hypothesis that post mortem tenderization might be due to dissociation of the actomyosin which formed during rigor mortis it was necessary in the current investigation to carry out a detailed study of the extraction procedure in order that actomyosin would not be extracted while at the same time no other proteins would be made insoluble in the extracting solution by the techniques being used. A refinement of the extraction procedure is being reported here.

Since the animals used in the present work were from an investigation of the effects of castration and hormones on feed lot gains, some of the data reported here are of interest in view of the increasing use of diethylstilbestrol in beef cattle feeding and in the role of castration in cattle management and carcass quality *(1, 16, 18)*.

EXPERIMENTAL

Animals studied. Thirty-two animals were used in this work; they were from a group of calves which had come from the same basic Hereford herd and were fed out to market weight at 13-16 months of age. For the feeding trials the rate and efficiency of gain of heifers, bulls, bulls with diethylstilbestrol implants, steers, and steers with diethylstilbestrol implants were compared. The results of the feeding trials and details of carcass quality and meat characteristics are reported elsewhere *(1)*.

Methods. The sampling techniques and methods used except as noted below, have been previously reported *(3, 8, 10, 11, 16, 17, 18)*. The meat was held as shortloin at 36-38° F. during post mortem aging.

Index of Refraction. This was determined at 10° C. using a Bausch and Lomb dipping refractometer. This temperature was selected in order to minimize denaturation of proteins.

Extraction Procedure. Observations made in the earlier study indicated that some refinements of the extraction of meat to remove most of the proteins other than actomyosin and stroma proteins should be made using both distilled water and a pH 5.6 potassium citrate buffer which was 0.22 M. potassium chloride and had 0.48 total ionic strength. The temperature of extraction was investigated with the results shown in Table 1. The cold room temperature was 2-3° C.

TABLE 1

The effect of temperature on the extractability (Young steer III: 25 g. meat/100 ml. solvent)

Post mortem carcass age	Percent total N extracted			
	K-citrate buffer		Distilled water	
	Cold room	Room temp.	Cold room	Room temp.
3 hrs.	67.22	43.81	36.13	31.49
24 hrs.	44.29	43.05	29.79	29.34
3 days	44.00	41.89	30.16	30.06
15 days	40.12	38.18	29.88	29.96
20 days	40.14	38.84	29.70	29.77
30 days	39.31	38.15	29.20	29.16

At 3 hours post mortem the higher amount of nitrogen extracted indicates that not all of the actin and myosin had reacted to give actomyosin. This is borne out also by the observation that the extracts at 3 hours post mortem became gelatinous on standing whereas later extracts did not. It is also quite

clear that some of the proteins are quite sensitive to heat and that distilled water is not particularly selective. This latter fact is well brought out in Table 2 which shows the effect of meat-extractant ratio on extractability. Note that the amount

TABLE 2
The effect of the meat extractant ratio on the extractability (Young steer III: 15 days post mortem)

Extraction number	The amount of meat (g.) per 100 ml. of extractant	Percent of total N extracted	
		K-citrate buffer	Distilled water
1	25	40.12	29.88
2	10	40.33	27.91
3	5	40.82	25.90

of nitrogen extracted by the potassium citrate buffer was relatively constant in comparison to the nitrogen extracted by water alone.

In view of the fact that some of the meat proteins are very sensitive to heat and the Waring blenders used in making the extraction heat up mixtures being blended, the effect of blending procedure on extractability was studied with the result shown in Table 3. It is quite clear that blending beyond 3 minutes

TABLE 3
Effect of procedure on extractability (Old cow I: 18 days post mortem) 25 g. meat/100 ml. buffer, 3-5° C.

Procedure	% Total N extracted
Blend 1 min.	41.33
Blend 1 min., stand 5 min., blend 1 min.	41.46
Blend 2 min.	41.24
Blend 2 min., stand 5 min., blend 1 min.	41.03
Blend 3 min.	41.50
Blend 4 min.	40.16
Blend 5 min.	40.27
Blend 6 min.	39.83
Blend 2 min., shake 15 min.	41.60
Blend 2 min., shake 30 min.	40.93
Blend 2 min., shake 60 min.	40.32

might lead to some denaturation. Accordingly the following blending procedure was used: 25 g. of meat and 100 ml. of extracting solution both below 10° C. were blended for 1 minute. The blender bowl was swabbed down and bowl and contents were allowed to stand 5 minutes, and then the blending was continued for an additional 30 seconds.

Using the above blending procedure a number of possible extracting buffers were compared.

It is of interest to note that the amount of nitrogen extractable with the potassium citrate buffer compares favorably with the acetate buffer of Hamoir *(6)* which is known not to extract actomyosin. The various phosphate buffers are reported to extract a small amount of actomyosin and this appears to be so from Table 4.

TABLE 4
Effect of buffer on extractability (Old cow IV: 25 g. meat/100 ml. buffer)

Buffer	pH	Ionic strength	% Total N extracted		Author
			1 day	18 days	
K-citrate + 0.22 M KCl	5.60	0.48	37.40	37.02	
K-acetate	7.00	0.50	37.92	37.46	Hamoir *(6)*
Phosphate + 0.5 M KCl	5.50	0.60	39.56	39.11	Hamoir *(7)*
Phosphate + 0.25 M KCl	6.80	0.35	44.26	42.61	Portzehl *(12)*
Phosphate + 0.25 M KCl	7.40	0.35	45.54	44.85	Dubuisson *(5)*
Phosphate + 0.30 M KCl	6.50	0.45	48.29	49.53	Szent-Gyorgyi *(14)*
0.3 M KCl		0.30	38.14	36.06	
0.6 M M KCl		0.60	42.59	42.29	
Water			24.74	24.77	

The relative solubilizing effect of potassium and sodium salts in the buffer solution was studied as shown in Table 5.

On the basis of nitrogen extract and the results noted above it appears that the pH 5.6 buffer made up of 0.22 M. potassium chloride and potassium citrate and citric acid to ionic strength 0.48 was most satisfactory.

From the foregoing experiments it appears that the greatest source of variation which might have been important in the earlier report was the temperature and manner of extraction.

The extraction procedure which appears to be the most satisfactory from the standpoint of separating actomyosin and stroma proteins from other proteins of meat follows:

The extracting buffer solution is made by mixing 69 ml. of solution A and 31 ml. of solution B. Solution A is 21.008 g. citric acid ($C_6H_8O_7 \cdot H_2O$) dissolved in 200 ml. 1.00 M. potassium hydroxide and sufficient 0.40 M. potassium chloride to

TABLE 5
The effect of potassium and sodium ions on the extractability (Old cow I: 17 days post mortem)

Extraction number	Extractant	Percent of total N extracted
1	K-citrate buffer, pH 5.6, + 0.22 M KCl	37.35
2	K-citrate buffer, pH 5.6, + 0.22 M NaCl	36.94
3	Na-citrate buffer, pH 5.6, + 0.22 M KCl	36.46
4	Na-citrate buffer, pH 5.6, + 0.22 M NaCl	36.39
5	Distilled water	27.44

make 1 liter. Solution B is 0.100 M. potassium hydroxide. The final buffer is pH 5.60 ± 0.05, 0.22 M. potassium chloride and 0.48 ionic strength.

Twenty-five grams of meat sample and 100 ml. of the above buffer both below 10° C. are blended for 1 minute in a Waring blender. The sides of the bowl are swabbed down and the mixture is allowed to stand 5 minutes after which it is blended for 30 seconds. The slurry is then centrifuged 20 minutes at 800 × gravity. All operations are carried out in the cold room so that at all times the temperature of meat and mixture never go above 10° C. Nitrogen is determined in the supernatant and the protein fractionation is reported as percent total nitrogen extracted. One hundred minus this figure is a good estimate of actomyosin plus stroma proteins, and most of this is actomyosin particularly at 1-2 days post mortem (see below).

Data on water extraction in the following section was obtained using the same procedure recommended above except that distilled water replaced the buffer.

Juice or Moisture Loss on Cooking. When meat is cooked the muscle plasma coagulates and forms a fiber, and fluid is expressed by the coagulating protein. This fluid is the juice or shrinkage loss and amount of juice expressed may be related to the degree of protein hydration and/or to the degree of proteolysis. Accordingly, the following standard procedure was adopted. Fifty grams of meat is weighed into a 250 ml. centrifuge bottle. The bottle is tightly stoppered with a rubber stopper and placed in a boiling water bath for exactly 30 minutes. The bottle is allowed to cool and the juice is then decanted into a graduated 15 ml. centrifuge tube, spun down, and the amount juice was determined directly after correcting for fat or solid matter, if any. Experiments are currently underway to improve this procedure.

RESULTS

Since the interpretation of much of the subsequent data depends upon the extraction of nitrogen it was desired to recheck the observation of Husaini *et al. (10)* that during post mortem aging there is little or no proteolysis as indicated by the fractionation of non-protein nitrogen and trichloracetic acid soluble nitrogen *(9)*. Table 6 shows excellent confirmation and indicates that only in the most advanced aging does the amount of

TABLE 6

Changes in trichloracetic acid soluble and non-protein nitrogen during post mortem aging

Post Mortem Age, days at 2.3° C.	3	13	30	40
Number of Animals	6	6	1	1
Trichloracetic acid soluble, % Total N.	12.34	11.88	13.77	15.68
St. Dev.	0.64	0.68	—	—
Non-protein nitrogen, % Total N.	8.58	8.55	8.62	9.26
St. Dev.	0.43	0.28	—	—

non-protein and trichloracetic acid soluble nitrogen increase. Furthermore, the one sample held 40 days was quite obviously "over-ripe." Therefore it is quite evident that post mortem changes in nitrogen fractions to be noted below are not the result of changes in non-protein or trichloracetic acid soluble nitrogen.

Some of the data obtained on the 32 cattle which were studied in some detail appear in Table 7.

It is clear that the interpretation of some of the results is difficult for two reasons: (1) the small number of animals per group and (2) the uniformity in age and feeding—all animals were young and well fed.

Grading standards favor steers and heifers over bulls. The effect of diethylstilbestrol tended to upgrade bulls slightly and downgrade steers significantly. In the latter case the significantly lower intra-muscular fat was partly responsible.

The results on tenderness both at 3 and 13 days post mortem indicate that no significant relation exists between intramuscular fat and tenderness. These data

TABLE 7

Tenderness and biochemical characteristics of 32 carcasses at 3 and 13 days post mortem

Animal no.	Tenderness		Carcass grade	Moisture %	Fat %	Total-N %	Hydroxy-proline %	Cyano-metmyo-globin %	Juice % total moisture		pH		Water extract % total-N		K citrate buffer extract % total-N	
	3 days	13 days							3 days	13 days	3 days	13 days	3 days	13 days	3 days	13 days
Heifers																
10		8.75	1.0	67.63	7.98	3.395	.0309	.295		35.8		5.48		28.91		33.71
7		8.17	1.0	65.25	9.67	3.341	.0369	.365		27.5		5.46		23.10		38.96
6		7.92	1.0	69.29	5.78	3.535	.0443	.350		35.0		5.46		30.24		41.18
8		7.92	1.0	63.61	9.00	3.451	.0391	.288		32.0		5.48		22.67		37.59
9		7.17	1.0	67.53	6.19	3.238	.0327	.444		35.6		5.50		31.16		42.63
1	5.92	6.83	1.0	68.88	8.46	3.351	.0390	.473	39.3	38.1	5.48	5.66	26.87	24.63	38.36	33.11
Mean		7.79	1.0	67.03	7.85	3.385	.0372	.369		34.0		5.51		26.79		37.86
St. Dev.		0.69	0.0	2.19	1.58	0.102	.0050	.173		3.7		0.08		3.76		3.87
St. Error		0.28	0.0	0.89	0.64	0.042	.0020	.061		1.5		0.03		1.53		1.58
Regular Bulls																
32	7.33	8.33	2.0	70.45	3.84	3.494	.0309	.487	38.2	34.8	5.43	5.51	27.20	26.13	39.44	34.84
30	5.08	8.00	3.0	73.23	1.87	3.381	.0438	.610	38.9	36.0	5.48	5.54	27.31	27.70	40.74	38.98
29	4.25	7.83	2.4	73.77	1.76	3.490	.0382	.522	40.6	37.4	5.45	5.61	26.92	25.38	38.34	37.46
31	3.33	6.75	2.4	72.84	1.89	3.485	.0363	.564	40.0	36.2	5.46	5.54	28.33	26.48	38.51	36.44
3	4.92	6.67	2.4	73.84	2.72	3.466	.0418	.462	38.5	37.1	5.50	5.57	27.08	23.65	37.46	32.25
Mean	4.98	7.52	2.44	72.83	2.42	3.462	.0382	.529	39.2	36.3	5.46	5.55	27.37	25.87	38.90	35.99
St. Dev.	1.48	0.75	0.36	1.39	0.88	0.047	.0051	.059	1.0	1.0	0.03	0.04	0.56	1.50	1.14	2.98
St. Error	0.66	0.33	0.16	0.62	0.39	0.021	.0023	.027	0.5	0.5	0.01	0.02	0.25	0.67	0.51	1.32
Bulls implanted with diethylstilbestrol																
27	4.17	8.00	2.0	72.76	2.85	3.505	.0361	.461	38.7	36.1	5.41	5.50	26.73	26.13	38.81	36.63
5	5.08	7.33	2.7	73.42	2.19	3.361	.0491	.628	39.3	36.6	5.48	5.66	27.12	26.80	38.26	35.56
16	4.25	7.00	2.0	72.15	3.18	3.631	.0403	.510	36.7	36.1	5.41	5.57	27.32	26.80	39.25	36.55
17	3.92	6.50	2.0	72.38	2.92	3.587	.0451	.362	38.7	37.6	5.48	5.54	26.34	25.34	37.79	35.32
28	4.42	6.33	2.4	71.99	2.20	3.508	.0389	.522	36.9	33.6	5.44	5.50	29.05	26.20	40.00	35.13
Mean	4.37	7.03	2.22	72.54	2.67	3.518	.0419	.497	38.1	36.0	5.44	5.55	27.31	26.25	38.82	35.84
St. Dev.	0.46	0.67	0.32	0.57	0.45	0.104	.0052	.097	1.2	1.5	0.04	0.07	1.04	0.62	0.86	0.79
St. Error	0.20	0.30	0.14	0.25	0.20	0.046	.0023	.043	0.5	0.7	0.02	0.03	0.46	0.28	0.38	0.35
Regular Steers																
41	5.58	8.58	1.4	66.89	9.51	3.380	.0296	.451	38.8	35.3	5.46	5.50	27.91	24.56	41.97	33.29
42	7.08	8.50	1.4	67.02	8.40	3.396	.0417	.441	37.3	35.9	5.37	5.43	30.51	26.97	40.56	35.13
44	6.33	8.17	1.4	68.79	7.51	3.253	.0319	.520	37.8	36.7	5.35	5.46	30.84	29.52	43.66	39.54
39	7.50	8.00	1.0	65.27	11.01	3.386	.0333	.446	38.1	30.9	5.43	5.53	27.89	23.81	40.03	32.16
40	7.17	7.83	1.0	65.75	11.02	3.275	.0318	.394	38.9	33.4	5.39	5.50	29.78	26.75	41.02	35.32
19	6.75	7.50	1.7	69.54	4.94	3.507	.0356	.396	36.7	36.0	5.47	5.62	28.40	26.68	38.53	34.90
14	6.33	7.08	1.0	69.61	4.49	3.348	.0312	.457	38.5	34.4	5.44	5.68	32.73	26.76	45.49	35.67
18	6.08	7.08	1.0	65.94	10.99	3.494	.0313	.514	35.5	35.4	5.47	5.56	27.89	24.02	37.99	32.82
43	5.42	6.92	1.7	69.89	7.44	3.381	.0419	.367	39.1	38.4	5.42	5.46	28.40	28.25	41.84	38.49
4	4.33	6.83	2.0	73.34	2.63	3.468	.0416	.403	42.9	41.6	5.41	5.65	27.84	25.40	37.82	34.64
20	5.17	6.50	1.4	67.18	9.27	3.522	.0398	.318	39.5	36.3	5.46	5.49	27.94	24.33	38.71	32.82
Mean	6.16	7.54	1.36	68.11	7.93	3.401	.0354	.426	38.5	35.8	5.42	5.53	29.10	26.10	40.69	34.98
St. Dev.	0.96	0.71	0.34	2.39	2.87	0.089	.0049	.059	1.9	2.7	0.04	0.08	1.64	1.84	2.02	2.53
St. Error	0.29	0.21	0.10	0.72	0.86	0.027	.0015	.018	0.6	0.8	0.01	0.03	0.50	0.56	0.61	0.70
Steers implanted with diethylstilbestrol																
11	6.83	8.08	2.0	71.27	2.48	3.536	.0361	.466	36.0	33.7	5.38	5.56	28.87	24.70	41.23	33.20
2	5.17	6.67	2.0	72.33	3.60	3.397	.0352	.407	37.5	37.1	5.42	5.57	28.84	27.74	38.88	37.09
15	5.92	6.67	2.0	70.47	2.88	3.577	.0397	.466	40.0	39.7	5.50	5.63	30.45	25.99	41.73	33.63
12	4.75	6.58	2.0	70.04	3.06	3.400	.0366	.436	40.5	34.5	5.47	5.58	28.89	25.58	42.59	35.09
13	5.75	6.08	1.4	70.25	4.42	3.362	.0397	.455	39.4	36.4	5.46	5.64	28.94	25.32	41.25	35.70
Mean	5.68	6.82	1.88	70.87	3.29	3.454	.0375	.446	38.7	36.3	5.45	5.60	29.20	25.87	41.14	34.94
St. Dev.	0.79	0.75	0.27	0.94	0.75	0.095	.0021	.025	1.9	2.4	0.05	0.04	0.70	1.15	1.38	1.58
St. Error	0.35	0.33	0.12	0.42	0.34	0.043	.0009	.011	0.8	1.1	0.02	0.02	0.31	0.51	0.62	0.71

clearly confirm the previous report from this laboratory *(16)* that marbling seems to be predominantly a sex characteristic. It is important to note also that the amount of marbling is depressed when steers are treated with diethylstilbestrol.

The pigment cyanomethyoglobin [which includes some methemoglobin *(16)*] appears to be less for heifers than for the other groups.

Tenderness differences between groups at 3 and 13 days show only trends since the numbers of animals in each group are small yet in all cases tenderness increased with post mortem age. At 13 days post mortem the differences between heifers, bulls, and steers were not significant. If a trend is shown it is the slightly less tender meat of the diethylstilbestrol treated animals in relation to their respective untreated groups. This trend was seen in a previously reported group of bulls *(16)*. At 3 days the untreated steers as a group were more tender than the treated bulls with the other group being intermediate.

Hydroxyproline, which is indicative of total connective tissue, showed a similar trend to tenderness between groups but in reverse order—that is, treated groups tended to have slightly more hydroxyproline. This effect can be seen in the previous report *(16)* between the more comparable groups of treated and untreated bulls. Although these trends in hydroxyproline and tenderness may influence the composite picture (see below) much more definitive investigation on these matters must be carried out before these effects can be specifically related to hormone treatment rather than other management factors or chance groupings.

Since the number of animals in each group is small it is necessary that all groups be combined for more critical statistical study of the relationship of tenderness to certain biochemical data in Table 7. This may introduce a bias but even so some interesting relationships exist and these may shed considerable light on the interpretation of the possible nature of post mortem tenderization.

Connective tissue as hydroxyproline seems to be playing some part in the tenderness of the meat at 3 days post mortem and somewhat less significantly at 13 days. This indicates that the meat studied in this series is less homogeneous than in the previous study since connective tissue may be playing a significant part in the tenderness differences between animals. This means that in this group of animals, which do not show great differences in tenderness, the role of various factors in muscle plasma toward the quality of tenderness may be less pronounced than desired.

A significant, although small, decrease in the amount of water extractable nitrogen occurs between 3 and 13 days post mortem. Only one animal (No. 30) out of a total of 27 reversed this trend and this to only a minor degree which is within the order of magnitude of errors in method. This decrease in water soluble proteins indicates protein changes which may be thought of as denaturation or perhaps protein-protein interaction. Irrespective of the nature of the changes it is significant that the amount of water soluble nitrogen appears to be related positively to tenderness at 3 days post mortem. At 13 days this relation is less pronounced and tends to disappear but this may be due in part to the smaller and more skewed distribution of tenderness values after aging.

The data obtained using potassium citrate buffer which was designed to extract proteins other than actomyosin and stroma proteins tends to parallel the results for water extractable nitrogen. In all 27 animals the amount of nitrogen extracted by the buffer decreased during aging. This is contrary to the earlier report *(18)* and indicates that in the older extraction procedure at the higher temperature significant denaturation was taking place. That denaturation was taking place is also indicated by lower absolute values and by the fact that some of the proteins appeared to be less sensitive to heat after aging.

Since in all cases the buffer extracted less protein at 13 days than at 3 days, it appears that the hypothesis that increases in tenderness with post mortem age are due to the dissociation of actomyosin into actin and myosin will have to be discarded. Even so the results in Table 8 indicate a relation between actomyosin and tenderness at 3 days post mortem ($r = 0.424$) and that actomyosin does play a role in the tenderness of meat. The disappearance of the interaction at 13 days post mortem may be for reasons similar to those given above for the water extractable nitrogen.

The decrease in nitrogen soluble in the buffer is probably not due to increase in actomyosin with post mortem age. This decrease probably is due to denaturation, a protein-protein interaction, or some other

TABLE 8

Correlation of tenderness at 3 and 13 days to nitrogen extracted, hydroxyproline, and juice expressed on cooking

Quality factor	Days post mortem	No. of animals	Mean	St. dev.	St. error	Correlation coefficient	Probability
Tenderness	3	27	5.51	1.15	0.22		
Tenderness	13	32	7.39	0.75	0.13		
Hydroxyproline %	3	27	0.0376	0.0049	0.0009	−.463	.02-.01
Hydroxyproline %	13	32				−.354	.05-.02
Juice as % Total H_2O	3	27	38.60	1.56	0.30	−.407	.05-.02
Juice as % Total H_2O	13	32	35.66	2.54	0.45	−.403	.02-.01
Juice as % Total H_2O	3 + 13	59	37.01	2.90	0.34	−.481	<.01
(a) Water Extracts							
% Total N Extracted	3	27	28.38	1.48	0.29	+.429	.02-.01
% Total N Extracted	13	32	26.18	0.87	0.16	+.306	.10-.05
(b) Buffer Extracts							
% Total N Extracted	3	27	40.01	1.83	0.35	+.424	.02-.01
% Total N Extracted	13	32	35.81	2.61	0.46	+.134	.50

phenomenon giving rise to proteins of different solubility. This is supported also by the data on water extractable nitrogen. It is worthy of note that Dubuisson *(4)* observed the appearance of new protein species in rabbit muscle 48 hours post mortem. Evidence to support this view will appear in a later paper.

Indices of refraction were determined on all buffer and water extracts at 3 and 13 days post mortem. In all instances the indices dropped with post mortem age. These data are not shown in Table 7, but there was a very highly significant but still not a direct relation to nitrogen content of the extract. The relation between index of refraction of extract and tenderness reported in 1954 was not confirmed using the newer extraction procedure.

The fact that the extractable nitrogen decreases with post mortem age for both water and buffer supports the view that classical proteolysis does not appear to take place during post mortem aging.

To test the hypothesis that post mortem tenderization might be related to the water holding capacity of proteins the juice expressed on cooking in a standard manner was measured as a possible index to the degree of protein hydration. These data in Table 7 clearly show that in all cases there was a decrease in the amount of juices (or shrinkage) during aging. The correlation coefficients in Table 8 indicate that the juice expressed is inversely related to tenderness both at 3 and 13 days post mortem. When these data are pooled, a still higher correlation coefficient is obtained. How much of this is due to bias introduced by combining the 3 and 13 days is not known. In any case the role of protein hydration in understanding post mortem changes in meat can not be neglected since it may be that tenderness, shrinkage in cooking, drip on freezing, and even rehydration after dehydration of meat may be closely interrelated.

To further study protein hydration during post mortem aging two kinds of information are pertinent—pH and ion-protein interrelationships. pH data in Table 7 clearly confirm the earlier report *(18)* that during post mortem aging pH shifts slightly toward alkalinity. There is not a single case where the pH dropped. Hence the pH shift is away from the isoelectric point of muscle protein causing an increase in water holding capacity. Information on some of the post mortem ionic shifts in muscle (meat) will be reported in a subsequent paper.

Since pH, juice expressed on cooking, water extractable nitrogen and nitrogen extracted by the potassium citrate buffer change with post mortem age along with tenderness between 3 and 13 days, more detailed study of these changes seemed desirable. Accordingly, beginning at 2-3 hours post mortem the four chemical factors were determined over a 30-day aging period. Tenderness could not be determined because of insufficient meat.

Figure 1 shows the changes in water and buffer extractable nitrogen for two steers and one cow beginning at 2 or 3 hours post mortem. Notice the precipitous drop in buffer extractable nitrogen shortly after slaughter. This clearly indicates that actomyosin which is insoluble in the buffer is being formed during the onset of rigor mortis. Further evidence of this is the observation that buffer extracts became gelatinous on standing until the minimum extractability was reached. These findings clearly support the suggestions of Szent Gyorgyi *(15)* and Dubuisson *(4)* that rigor mortis is the post mortem formation of actomyosin. At rigor mortis or 12-24 hours post mortem a minimum extracta-

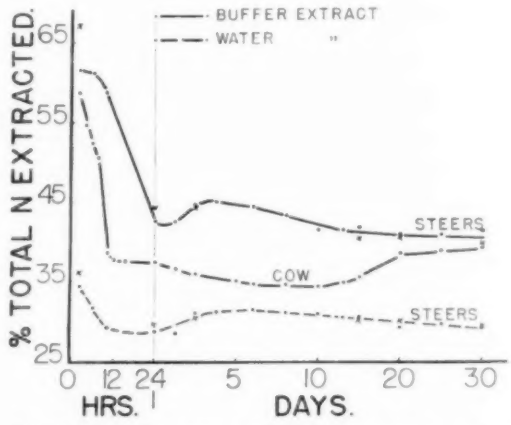


Figure 1. Post mortem changes in the nitrogen extracted by potassium citrate buffer (pH 5.60, 0.22 M. potassium chloride, 0.48 total ionic strength) and by water for two steers and one cow.

bility is reached and then there appears to be a slight increase at 3-5 days post mortem followed by a gradual decline. The curves for the meat of the two steers agreed quite well but that for the cow beef showed a more exaggerated drop and more prolonged minimum although the forms of the curves were generally the same. The significance, if any, for the differences between the cow and steer meat is not presently apparent although different chilling rates may be a contributing factor and it was also observed that rigor mortis set in quite rapidly in the case of the cow.

The changes observed in the water extractable nitrogen for the meat from the two steers show excellent agreement and the form of the curve is the same as for the buffer extract. However, the order of magnitude of the changes in water extractable nitrogen is not great and reflects the fact that myosin as well as actomyosin and perhaps other proteins are less soluble in water than in the buffer.

Figure 2 shows the changes in pH and juice expressed on cooking for the meat from the same two steers. Again there is excellent agreement between the meat of both steers for both juice and pH. pH drops rapidly after slaughter and reaches a minimum at 3 days and then gradually increases. Coincidently with these pH changes are changes in juice expressed on cooking. During the first 24 hours shrinkage losses rapidly increase to a maximum and then gradually decrease and at 30 days appear to approach the value observed at 2 or 3 hours post mortem. To be sure the hydration of the proteins is inversely related to the shrinkage of the meat or juice expressed on cooking and is also pro-

foundly affected by pH. However, the facts that the pH minimum does not strictly coincide with the juice maximum and that the changes in juice are large compared to pH shifts after 3 days post mortem indicate that biochemical factors other than pH alone are controlling protein hydration. In this connection it is of interest to note that minimum extractability by water

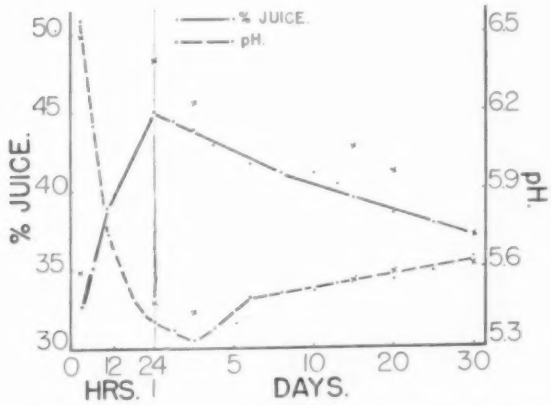


Figure 2. Post mortem changes in juice expressed on cooking and in pH for two steers.

and by buffer seems to coincide with maximum juice rather than minimum pH. All of these observations suggest that during post mortem tenderization ion-protein or protein-protein interactions may be playing important roles.

It will be recalled that meat taken at slaughter is initially tender and reaches the least tender state at 1-3 days post mortem *(13)*. As aging time increases so also does tenderness *(2)*. Since these changes in tenderness seem to coincide with those of juice, pH, water, and buffer extractability, it is apparent that there is a close interrelation between these factors and tenderness. Indeed a relation has been observed as noted in Table 8 above. It appears that tenderness is closely related to degree of hydration of the meat proteins as reflected in the amount of juice expressed on cooking. If this proves to be so, then tenderness, shrink on cooking, drip on freezing, and rehydration after dehydration—all properties of meat of prime importance to the processor and consumer—are primarily based on the water holding capacity of meat proteins.

SUMMARY

Tenderness and biochemical characteristics of the meat from 32 animals which included heifers, bulls, bulls implanted with diethylstilbestrol, steers, and steers implanted with diethylstilbestrol have been determined at 3 and 13 days post mortem.

No great differences were noted between groups on tenderness at 13 days post mortem although the hormone treatment tended to produce slightly tougher meat at both 3 and 13 days post mortem.

Hydroxyproline values were slightly higher in the meat from the hormone treated cattle.

Intramuscular fat was greatest in steers and heifers and least in bulls and the hormone treated steers yielded less marbled meat. The results on marbling confirmed an earlier report *(16)* that intramuscular fat appears to be a sex characteristic rather than a mark of tenderness *per se*.

An earlier report *(10)* was confirmed that there is no increase in non-protein and trichloracetic acid soluble nitrogen during post mortem tenderization.

Water extractable nitrogen and potassium citrate soluble nitrogen decrease during post mortem aging indicating that dissociation of actomyosin into actin and myosin is not responsible for post mortem tenderization.

Actomyosin is formed during the onset of rigor mortis and this may account for the initial toughening of meat after slaughter.

Juice expressed on cooking decreases on post mortem aging and a significant relation was observed between this factor and tenderness of meat at 3 and 13 days post mortem.

Post mortem pH changes have been observed which might contribute to increased protein hydration during post mortem aging.

Water and potassium citrate buffer extractable nitrogen, pH, and juice expressed on cooking have been studied from 2 hours to 30 days post mortem. Coincident changes in these factors suggest a close relation to tenderness and support the hypothesis that post mortem tenderization may be an ion-protein or a protein-protein interaction which contributes to increased protein hydration of the cooked meat proteins.

The suggestion is offered that the important qualities of meat-tenderness, shrink on cooking, drip on freezing, and rehydration after dehydration may all be primarily related to the degree of hydration of the meat proteins.

Acknowledgment

The authors are grateful to Kingan and Company for a grant-in-aid which made some of this work possible.

Miss Nancy Arnold has given valuable technical assistance in part of these investigations.

LITERATURE CITED

1. Cahill, V. R. Effect of diethylstilbestrol implantation on carcass composition and the gross weight of certain endocrine glands of steers and bulls. (Ph.D. dissertation, Ohio State University, 1955).
2. Deatherage, F. E., and Harsham, A. Relation of tenderness of beef to aging time at 33-35° F. *Food Research*, 12, 164-172 (1947).
3. Deatherage, F. E., and Reiman, Walter. Measurement of beef tenderness and tenderization of beef by the Tenderay process. *Food Research*, 11, 525-534 (1946).
4. Dubuisson, M. Modifications dans la structure physico-chemique de l'édifice contractile au cours du cycle de la contraction musculaire. *Biochim. et Biophys. Acta*, 4, 25-37 (1950).
5. Dubuisson, M. Muscle activity and muscle proteins. *Biol. Revs.*, 25, 46-72 (1950).
6. Hamoir, G. Nouvelle methode de separation des myosines α et β. *Experientia*, 3, 498 (1947).
7. Hamoir, G. Fish tropomyosin and fish nucleotropomyosin. *Biochem. J.*, 48, 146-150 (1951).
8. Hershberger, T. V., Deans, R., Kunkle, L. E., Ger-

LAUGH, P., AND DEATHERAGE, F. E. Studies on Meat III. The relation of certain feeding management practices to the biochemistry and quality of beef. *Food Technol.*, **5**, 523-527 (1951).
9. HILLER, H., AND VAN SLYKE, D. D. A study of certain protein precipitants. *J. Biol. Chem.*, **53**, 253 (1922).
10. HUSAINI, S. A., DEATHERAGE, F. E., AND KUNKLE, L. E. Studies on Meat II. Observations on the relation of biochemical factors to changes in tenderness. *Food Technol.*, **4**, 366-369 (1950).
11. HUSAINI, S. A., DEATHERAGE, F. E., KUNKLE, L. E., AND DRAUDT, H. N. Studies on Meat I. Biochemistry of meat as related to tenderness. *Food Technol.*, **4**, 313-316 (1950).
12. PORTZEHL, H., SCHRAMM, G., AND WEBER, H. H. Aktomyosin und seine Komponenten. I. *Z. Naturforsch.*, **5b**, 61-74 (1950).
13. RAMSBOTTOM, J. M., AND STRANDINE, E. J. Initial physical and chemical changes in beef as related to tenderness. *J. Animal Science*, **8**, 398-410 (1949).
14. SZENT-GYORGYI, A. *Chemistry of Muscular Contraction*, 1951, Academic Press, Inc., New York, pp. 146-148.
15. SZENT-GYORGYI, A. *Chemical Physiology of Contraction of Body and Heart Muscle*. 1953, Academic Press, Inc., New York.
16. WIERBICKI, EUGEN, CAHILL, V. R., KUNKLE, L. E., KLOSTERMAN, E. W., AND DEATHERAGE, F. E. Effects of castration on the biochemistry and quality of meat. *J. Agr. Food Chem.*, **3**, 244-249 (1955).
17. WIERBICKI, EUGEN, AND DEATHERAGE, F. E. Hydroxyproline as an index of connective tissue in muscle. *J. Agr. Food Chem.*, **2**, 878-882 (1954).
18. WIERBICKI, EUGEN, KUNKLE, L. E., CAHILL, V. R., AND DEATHERAGE, F. E. The relation of tenderness to protein alterations during post mortem aging. *Food Technol.*, **8**, 506-511 (1954).

Positional Bias in Sensory Assessments

J. M. HARRIES

Scientific Adviser's Division (Food), Ministry of Agriculture, Fisheries and Food, London

(Manuscript received August 18, 1955)

A tendency to choose the central sample of three as the odd one in triangular tests, noted by Harrison and Elder (*6*) has been confirmed, and a similar phenomenon is shown to exist in the "two-out-of-five" tests used in the Ministry of Agriculture, Fisheries and Food. In the latter, this bias is at least considerably reduced by circular presentation. A similar bias is also found when samples are scored according to a pre-arranged arbitrary scale, and one method of allowing for it is discussed.

Investigations in food technology often depend upon sensory assessment of the results, and it is frequently possible to use a type of test called the direct difference test, typified by the well known triangular test. There is a considerable literature, as for example Boggs and Hanson *(1)*, on this type of test, in which 3 samples of a foodstuff, two of which are duplicates, are presented to a taste-panel and coded in a random manner. The members are informed of this and are asked to identify the odd sample. Each member has one chance in three of making the correct identification even when he is not really capable of distinguishing between the samples and the odds against any given number of people identifying the duplicates are calculable. The construction of a test of significance for differences in palatability between two kinds of a foodstuff is therefore straightforward.

Harrison and Elder *(6)* have described a psychological hazard which arises in the use of the triangular test. They found that, in the absence of true organoleptic discrimination, there was an outstanding and significant tendency to choose the middle sample of the three as the odd one when the samples were presented in a line. To check this finding a series of triangular tests was carried out in this Division with orange juice, when in fact the same juice was used throughout, but the tasters were told that the 3 samples could be separated into a pair and a singleton. All the samples were placed in line before the tasters occupied the tasting-booths, and there was no restriction on the order or frequency with which they were to be tasted. Six tests were done, each with 10 people, and each of the 3 samples should have been chosen as the odd one an equal number of times, within the limits of chance expectation. The results are shown in Table 1 and it is clear that the second (central) sample was chosen more frequently as the odd sample than the other two, a result which a straightforward χ^2 test shows to be statistically significant. [Calculated from the totals, a value of χ^2 of 7.6 with 2 degrees of freedom is obtained, which gives $p<.05$]. The chance of success in the absence of a real ability to discriminate in a triangular test would appear from Table 1 to be about one-half when the central sample of three is in fact the odd sample, and about one-quarter when the odd sample is one of the other two. This is in fairly close agreement with the results given by Harrison and Elder *(6)*.

TABLE 1

Frequency of identification in triangular tests when all three samples were, in fact, of the same product

Test number	Number of times identified as the pair		
	1 and 2	1 and 3	2 and 3
1	3	5	2
2	1	6	3
3	4	4	2
4	2	6	2
5	4	4	2
6	2	5	3
Total	16	30	14

Bias in a Two-out-of-Five Difference Test

The same type of bias has been found to exist in the two-out-of-five tests used in the Scientific Adviser's Division (Food) of the Ministry of Agriculture, Fisheries and Food. These are similar to triangular tests, except that 2 samples of one kind of foodstuff, and three of another, are presented to the panel *(5)*. The chance of success, in the absence of a real ability to discriminate, is one-tenth, and they are considered to be more sensitive and therefore more suitable than triangular tests when the number of people available for taste-panel work is limited. [For a discussion of sensitivity in this sense, see Fisher *(2)*, and Gridgeman *(4)*. Fisher's statement on maximum sensitivity for a given total number of samples does not hold in this type of test]. One disadvantage is that the risk of fatigue is greater, and two-out-of-five tests are not used for particularly cloying foods. There seems to be no agreement in the literature about the number of samples that can be tasted without risk of fatigue, possibly because different workers have been concerned with different foods. Liberal use of palate-cleansers and strict instructions to tasters to take their time seem to be effective in minimising any risk. Since it affects discrimination, however, fatigue is irrelevant to the present issue, which is concerned with the supposedly random behaviour of tasters in the null case, i.e. in the absence of discrimination.

Table 2 shows the frequency with which each possible pairing was made in a series of two-out-of-five tests

TABLE 2
Frequency of incorrect pairing when five samples were presented in a line

Pairings	No.
1 and 2	5
1 and 3	6
1 and 4	2
1 and 5	20
2 and 3	7
2 and 4	11
2 and 5	11
3 and 4	9
3 and 5	4
4 and 5	7
Total	82

with soup. In these tests, there were differences between the two kinds of soup, and the object of the investigations was to discover whether these treatment differences caused a difference in any sensory characteristic. Five samples (three of one soup and two of another) were presented in a line in randomised order and the tasters were asked to state which constituted the pair and which the triad. In the first few tests, the results of which are quoted here, there were no significant differences, and any correct pairings (which were presumably chance occurrences) have been excluded from the data. The identity of correct pairs was varied at random and checked to ensure that no particular pairing occurred too often.

It will be seen that there was a strong tendency to pair samples 1 and 5, the end samples, at the expense of some of the other possible pairings. The distribution of Table 2 is significantly different from chance expectation.

The effect of the bias. The above results invalidate the statistical test of significance which is usually applied to this type of experiment because such a test assumes that each sample has an equal chance of being judged to be the odd one (or one of the pair) when no member can really distinguish between them. When conducting these experiments the identity of the odd sample in the triangular test or of the pair in the two-out-of-five test is usually decided at random. The above findings make it clear that in the triangular test there is a greater chance of achieving a significant result when samples 1 and 3 are duplicates and 2 is the odd sample than would theoretically be expected. In the two-out-of-five test there is a greater chance of achieving a significant result when samples 1 and 5 are duplicates.

As a subsidiary experiment "two-out-of-five" tests were carried out twice with the same 18 people, using 2 types of orange juice known to differ very slightly in flavour when judged by a trained panel of tasters. The identity of the pair was deliberately arranged to be different in the 2 tests, being samples 2 and 5 in the first test, and samples 1 and 5 in the second, sample numbers reading 1 to 5 from left to right. In the first test, 4 people out of the 18 identified the pair correctly; in the second, there were 9 correct identifications out of 18. In the first case, therefore, it would be concluded that there was no significant difference between the 2 types ($p \simeq .07$); in the second case, it would be concluded that they differed very significantly ($p < .001$). This result is discussed later.

A method of eliminating the bias. Harrison and Elder *(6)* state that "the only satisfactory way out would seem to be to randomize the coding so that in any one taste test, the odd sample is coded 1, 2 and 3 (A, B, and C) an approximately equal number of times. Perhaps it might be sufficient if the coding were carried out as it is now, but each series of three was presented in haphazard spatial order." It is felt that the former method (which presumably means that the samples would be coded differently for each taster) is not entirely satisfactory, since those tasters whose samples were coded in a certain way would stand a better chance of success than the others and the results of direct-difference tests are often used in choosing the members of a regular panel; in addition, this method would complicate matters for the organiser of the experiment, since it is much more convenient to decode the results when all coding is the same in any one test. An attempt was therefore made to discover whether the arrangement of the samples in a circle, with sample numbers reading clockwise, gave rise to a similar type of bias. This was only attempted with the two-out-of-five test, and Table 3 shows the frequency of pairings obtained in a series of such tests with soup. As in Table 2, incorrect pairings only have been used from a number of tests in none of which was the number of correct pairings sufficient to demonstrate a significant difference between the samples. The identity of correct pairings

was again decided by reference to a table of random numbers, and no particular pairing was preponderant. In addition to placing the samples in a circle, their code numbers were written on the bottoms of the containers, and judges were not asked to record their results, but to push the two paired samples to one side.

TABLE 3
Frequency of incorrect pairings when five samples were presented in a circle

Pairings	No.
1 and 2	20
1 and 3	22
1 and 4	16
1 and 5	24
2 and 3	24
2 and 4	21
2 and 5	16
3 and 4	19
3 and 5	15
4 and 5	16
Total	193

The frequency distribution of pairings shown in Table 3 does not differ significantly from random expectation. This does not, of course, mean that no bias is apparent in direct difference tests when the samples are presented in a circle. A greater number of readings may well demonstrate the existence of a similar bias of lesser magnitude, and the lack of bias may have been due to the concealment of code numbers. In fact the distribution of Table 3 is in some ways similar to that of Table 2, but at least it has shown that no significant bias was apparent with circular presentation and concealed coding when the test was made with twice as many readings as the number required to demonstrate its significance with straight line presentation.

Psychological Bias in Scoring Six Samples

It is not often possible to use the direct difference type of test considered above, and an alternative method is to ask the tasters to allot scores to a number of samples according to a predetermined scale.

Two sets of data resulting from such experiments have been examined from the point of view of the bias found to exist in direct difference tests. In the first of these, 24 eggs, 12 from each of two treatments, were tasted in four sessions of 6 samples each, by each of 4 tasters. They were asked to allot separate scores to the white and the yolk, according to a pre-arranged system ranging from 0 to 7. The following is an analysis of variance of the marks given to the whites.

Source of variance	Sums of squares	Degrees of freedom	Mean square	F ratio
Between Treatments	17.51	1	17.51	13.17
Between Tasters	5.37	3	1.79	1.34
Interaction T.X.T.	6.03	3	2.01	1.51
Residual	117.08	88	1.33	
Total	145.99	95		

The fact that the interaction is not significantly greater than the residual error indicates that the data may be represented by an equation of the form *(7)*.

$$x_{jk} = a_j + b_k + \xi_{jk}$$

where x_{jk} represents any individual reading specified as lying in column j and row k, a_j is the constant quantity measuring the effect of the treatment common to all readings in column j, b_k is the constant quantity measuring the effect of the treatment common to all readings in row k, and ξ_{jk} is the difference between the actual reading in a particular cell and the theoretical reading arising from the treatments. The constants a_j and b_k have been estimated from the data for each j and each k, and the residuals ξ_{jk} then calculated. Though the variance between tasters did not prove to be significantly greater than the error variance, constants were fitted to the data for each taster.

The result of fitting these constants is to allow for effects due to the different treatments and to the fact that they were tasted by four different tasters. The residuals should be, and are presumed to be, random. This is dependent upon the fact that samples of different treatments are given sample code numbers at random. On average, therefore, no particular sample number should show a consistently higher residual in any direction than any other. In Figure 1 are shown the average residual errors for each of the 4 tasters, each point being the average over four separate and independent sessions, the coding of the samples being different in each session. Ideally, the lines shown in Figure 1 should be horizontal, and lie along the abscissa of the graph. It is never, however, expected that they should do so, and their departures from the horizontal axis illustrate the "errors" of the experimental data. It is assumed that these departures are random, but it will be seen from the figure that a distinct pattern is apparent, strikingly similar for the separate tasters. Each of the points plotted in Figure 1 is an average of 4 readings, one from each session, and the extent to which the individual readings fall into a pattern may be tested by applying the analysis of variance to the residuals calculated from the original data. This analysis,

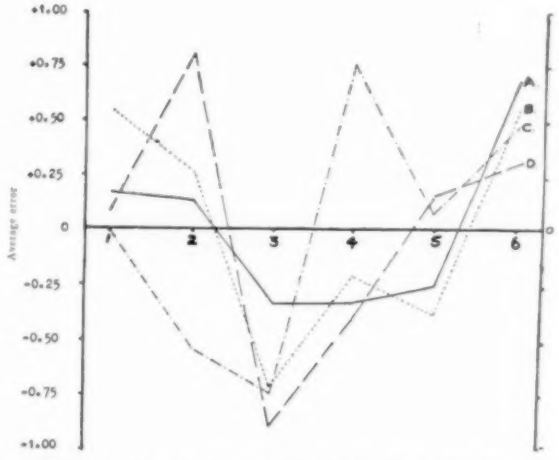


Figure 1. Bias in the scoring of six eggs, arranged by sample code number.
(A, B, C, and D are different tasters)

which really represents a splitting of the two sources of variance labeled "interaction" and "residual" in the foregoing table of variance, and which could have been calculated from the original data, without first computing the constants and residuals, is as follows:

Source of variance	Sums of squares	Degrees of freedom	Mean square	F ratio
Between Sample Nos.	11.425	5	2.285	1.76
Within Sample Nos.	111.520	86	1.297	
Total	122.945	91		

The F ratio in this analysis could have been obtained by chance in approximately 14% of trials if all the residuals were a random selection from the same universe. To be accounted significant in the conventional sense of the term (i.e. obtained by chance in 5% of trials) the F ratio needs to be above 2.32.

The second set of data used resulted from an experiment conducted by the Food Investigation Organisation of the Department of Scientific and Industrial Research, which involved the scoring of 54 samples of cod by a panel of 5 members drawn from the staff of D.S.I.R. and Scientific Adviser's Division of the (then) Ministry of Food. This was done in 9 sessions, using the score-scale described by Shewan, MacIntosh, Tucker and Ehrenberg *(8)*. Within each session, the 6 samples to be judged were given code numbers from 1 to 6 at random, and set out on a bench before the judges. Scores were allotted for raw appearance, raw odour, cooked flavour, cooked odour, and cooked texture. An analysis of variance of the data for raw odour showed that they could be represented by an equation similar to that used for the egg data, except that there were more constants to be fitted. The resultant residuals, due to tasting errors and "biological variation," both of which are presumed to be random, were again calculated, and Figure 2 shows in pictorial form the average residual for each taster for each sample code number. As with the egg data, these residuals, by definition, add to zero.

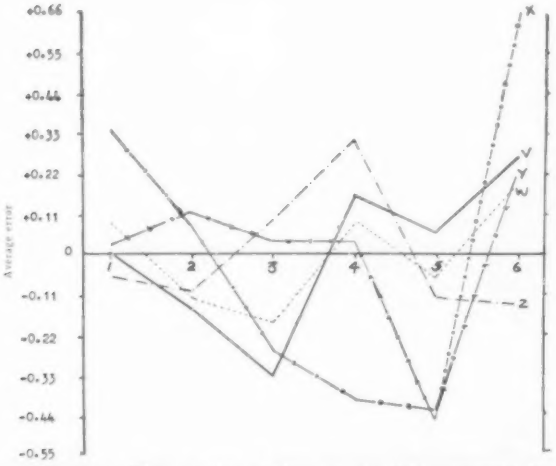


Figure 2. Bias in the scoring of six fish, arranged by sample code number.

(V, W, X, Y, and Z are different tasters)

The patterns exhibited in Figure 2 are again very similar from taster to taster, and the overall pattern is strikingly similar to that shown in Figure 1. The following is an analysis of variance of these calculated residuals, comparable to that given above for the egg data.

Source of variance	Sums of squares	Degrees of freedom	Mean square	F ratio
Between Sample Nos.	5.615	5	1.123	2.11
Within Sample Nos.	136.313	256	.5325	
Total	141.928	261		

An F ratio of about 2.25 would be obtained in 5% of trials, and of 1.87 in 10% of trials, so that the probability of achieving the above results by chance alone, under the hypothesis that all the residuals are members of the same universe, is about .07.

Since the same hypothesis (i.e. whether the residuals are randomly distributed amongst sample code-numbers) has been tested in two independent experiments, the probability values may be combined; the odds against obtaining the actual result in both experiments are about 99 to 1, so that it is concluded that sample code-number is a significant source of variance in such experiments. As will be seen from the accompanying figures, there are individual exceptions to the pattern, but it is clearly wrong to assume that the residual variation is random.

DISCUSSION

The above results, obtained in two different kinds of taste-panel enquiry, are in fairly close agreement, and point to the existence of a tendency on the part of tasters to treat at least the end samples of a line differently from the others. There is also a tendency when 6 samples are presented and scored according to a scale to give higher or lower marks to a sample according to its position. There are no data available to test the form of such psychological biases when direct difference tests are used with 6 samples or when a score scale is used with 5 samples. The reason for the pattern of behaviour discussed in this paper is probably of more interest to the psychologist than to the food technologist, though the latter will be concerned about its existence and about means of overcoming it.

A number of psychologists have shown that there are important differences between physical chance and chance involving a psychological element [e.g. Goodfellow *(3a, 3b)* and Whitfield *(9)*]. When human beings are given a choice and they expect a random order, symmetrical patterns are deliberately avoided, and certain non-symmetrical patterns are particularly popular, though the pattern seems to depend on the length of the series. In the direct difference tests described in this paper, a system was known or expected to exist, and symmetrical patterns were chosen more often than not. Most of the psychological work seems to involve a choice of two responses, and nothing comparable to the circumstances of the eggs and fish experiment has been found, but there is a remarkable similarity between the patterns exhibited in the attached

graphs and that found by Goodfellow *(3a)* in a "choice" experiment.

The evidence from the direct difference tests came solely from "null" cases, and it might be that the bias is only operative when there is no real difference between the samples under test. Whenever a real difference exists, the subconscious tendency to choose particular samples may be overridden by the choice of the correct ones. The subsidiary experiment described in Section 3 was intended to answer this question, but it was later thought to be inconclusive, since practice might have explained the increase in the number of correct response when the coding was altered. Unfortunately it was not possible to repeat the tests in the reverse order, to measure and allow for any practice effects, but experience indicates that though practice and training have a definite effect on response in such tests, the effect of practice alone was hardly likely to have been so great at such an early stage with tasters who had received no deliberate training. In the scoring tests, there were real, and highly significant, differences between the samples due to treatment.

It is clear that the phenomenon described in this paper is quite different from the suspected tendency to score a particular sample low if it follows a better one, and high if it follows a poorer one. In both the eggs experiment and the fish experiment the samples were laid out on a table and in most instances two or more tasters started simultaneously with different samples. Thus it seems that it is not the order of tasting which determines the pattern as much as the physical order of presentation on the table. The tests of significance applied to the residuals obtained from the egg and fish experiments compare the variation due to this psychological effect with what is known as normal biological variation, and show that the former is significantly greater than the latter. In other words the tendency, when first observed, could have been due to the accidental allocation of the same sample numbers to the "best" of the samples within each treatment. But this could hardly have happened with such consistency in both experiments, and in a preponderant number of sessions within each experiment. The egg experiment was carried out in London and the fish experiment at Grimsby; there were no tasters common to the two experiments; and the systems of scoring were different. Similar analyses could be carried out on the scores given to the whites in the eggs experiment, and on those given for other characteristics in the fish experiment, but since there would necessarily have been a correlation between the scores given for different characteristics of the same specimens, the emergence of a similar pattern would not be conclusive. When the observed tendency is so similar to that observed in the "difference" or "pairing" tests, there can be little doubt that the random coding of samples may well lead to fallacious results in either type of sensory test when the samples are presented in a straight line.

In sensory investigations involving a scoring system, the bias may be overcome by treating the sample code-number as a factor, including its effect in the main table of variance, and disregarding it in the tests of significance of the main treatment effects. Normally, the sample code-number would not be considered as a separate source of variance when sample numbers in different sessions are allocated at random; it would seem to be advisable to do so, however, since it has been shown that there exists a one-to-one correspondence between samples with the same code-number which is quite independent of, and significantly greater than, the variation due to factors other than those controlled in the experiment. If the variation between sample numbers is calculated and ignored, the residual variation will generally be less, but will be based on fewer degrees of freedom. Whether this will increase the precision of the experiment, and increase the chance of demonstrating the significance of the effects of the main factors, will depend upon the extent of the bias in any particular experiment. In the two examples used above, allowing for this bias makes little or no difference to the main results of the experiments, since these are, in any case, comfortably significant. Where results are fairly close to the arbitrary, but commonly accepted, levels of significance, the difference may be an important one, and it may be worth attempting to remove the bias by a different spatial arrangement of the samples (i.e., in the mechanics of the experiment) as was done with the direct difference tests, rather than by allowing for it in the analysis, when a lower residual variance would be obtained with the same number of degrees of freedom. The consequent increase in precision, however slight, is important in allowing greater reliance to be placed on data resulting from subjective assessments.

Acknowledgements

I wish to thank the members of the taste-panels whose results have been used in this paper, for their patience; Dr. James M. Shewan and the Department of Scientific and Industrial Research for permission to use the fish data; and Mr. T. Ffowc Hughes for assisting with the analyses and drawing the illustrations.

LITERATURE CITED

1. Boggs, M. M., and Hanson, H. L. Analysis of foods by sensory difference tests. *Advances in Food Research*, Volume II (1949).
2. Fisher, R. A. *The Design of Experiments.* 1935. Oliver and Boyd, Edinburgh.
3a. Goodfellow, L. D. *J. Expt. Psychol.*, **23**, 601 (1938).
3b. Goodfellow, L. D. *J. Gen. Psychol.*, **23**, 201 (1940).
4. Gridgeman, N. T. *Food Technol.*, **9**, 148-150 (1955).
5. Harries, J. M. Sensory tests and consumer acceptance. *J. Sci. Food Agric.*, **4**, 477 (1953).
6. Harrison, S., and Elder, L. W. Some applications of statistics to laboratory taste testing. *Food Technol.*, **4**, 434 (1950).
7. Kendall, M. G. *The Advanced Theory of Statistics.* Volume II, 1948, Griffin, London.
8. Shewan, J. M., MacIntosh, Ruth G., Tucker, C. G., and Ehrenberg, A. S. C. *J. Sci. Food Agric.*, **4**, 283 (1952).
9. Whitfield, J. W. *Quarterly J. Expt. Psychol.*, **2**, 76 (1950).

Studies on the Dehydration of Lima Beans[a]

A. I. NELSON, M. P. STEINBERG, H. W. NORTON, AND C. C. CLEVEN
University of Illinois, Urbana, Illinois

H. W. FRITZSCHE
Q.M. Food and Container Institute for the Armed Forces, Chicago, Illinois

(Manuscript received August 27, 1955)

The effect of four preparation factors and two storage conditions on acceptability and storage stability of dehydrated lima beans was investigated. The beans were blanched in water at two temperatures and three sulfiting treatments were used. Two dehydration temperature schedules, two moisture levels of finished product, two storage temperatures, and four storage times were employed. The experimental conditions were replicated four times and the results were statistically analyzed.

Sulfiting of the beans was necessary to preserve the color, flavor, and texture of the finished product especially at higher storage temperatures. Factors of blanching temperature, dehydration temperature schedule, and moisture level in the finished product were not significant. The interaction of storage time and temperature was highly significant. A very stable dehydrated product can be prepared from lima beans.

Considerable research has been carried out on the canning and freezing of lima beans, a popular vegetable with the American public. However, very little work has been published on the dehydration of lima beans. Although Caldwell *et al.* studied the suitability of 19 varieties of lima beans for dehydration, finding that most of these varieties were satisfactory as dehydrated products *(2)*, and Brown *et al.* also evaluated lima bean varieties for dehydration *(1)*, no detailed study has been made of the influence of preparation treatments, dehydration procedures, packaging conditions and effects of storage temperature and storage time on the acceptability of dehydrated lima beans.

The objective of the research described in this paper was to develop a procedure for the preparation, dehydration, and packaging of dehydrated lima beans that would yield an acceptable product after 6 months' storage at 100° F.

EXPERIMENTAL

The Clarks' Bush variety of lima beans was selected for this experiment. This is a small seeded, all-green variety of lima bean. The lima beans for each dehydration run were harvested just prior to preparation and processing. Commercial agricultural equipment was used for lifting the bean plants and shelling the lima beans. Viner operation including adjustment was similar to that used conventionally in the harvest of this crop.

The shelled product was transported to the processing laboratory where the beans were cleaned in a Standard 1 B Clipper cleaner equipped with an upper scalping screen of ¾ inch perforations and a lower screen of 11/32 inch perforations. A flotation-type and a rod reel (3/32 inch spacing between rods) washer were used for further cleaning the beans.

A 5-minute blanch at 195° F. and a 3-minute blanch at 210° F. in tap water were selected. Both of these blanching treatments were adequate to eliminate the peroxidase activity in the beans.

One-half and 1.5% sulfite concentrations were selected for treatment of the beans used in this experiment. A control, with no sulfite treatment, was also included. The sulfite solutions were made up by dissolving the salts in 30 lb. zeolite-softened water and adjusting the pH to 7.2 with HCl as follows:

0.5% solution (low treatment)
67 grams Na_2SO_3
56 grams $NaHSO_3$

1.5% solution (high treatment)
201 grams Na_2SO_3
168 grams $NaHSO_3$

This amount of solution was used to treat 80 lbs. of blanched lima beans. Before being placed in the dehydrator, the prepared beans were submerged in the sulfite solution for one minute. This was followed by a 5-minute drain period.

The initial dehydration from T_o[b] to a T value of 0.5 was carried out in a through-air-flow dehydrator described in a previous study *(3)*.

The following initial dehydration conditions were established:

1. High-temperature dehydration schedule

Step	T value range	Dry bulb, ° F.	Wet bulb, ° F.
1	T_o to 1.5	180	120
2	1.5 to 1.0	180	130
3	1.0 to 0.5	180	140

2. Low-temperature dehydration schedule

Step	T value range	Dry bulb, ° F.	Wet bulb, ° F.
1	T_o to 1.5	140	100
2	1.5 to 1.0	140	110
3	1.0 to 0.5	140	120

During the initial dehydration each tray load of product contained, in separate partitions, 35 lbs. each of no-sulfite, low-sulfite and high-sulfite treated beans. This arrangement allowed 105 lbs. of beans per tray or about 8 lbs. per square foot. The air flow was adjusted to 150 lineal feet per minute.

The finish or terminal dehydration was carried out with a dry bulb temperature of 120° F. The product remained in this drier for 12 hours or until the moisture content was reduced to at least 7%. At this point the samples designated as high-moisture were packaged under 26 in. of vacuum in No. 1 plain tin cans with the addition of water calculated to give a moisture content of 7%. Each can contained 125 g. of dehydrated lima beans.

The samples designated as low-moisture were packaged in the same manner except that no water was added and an in-package desiccant was included in each can. In these samples, 100 g. of lima beans (about 7% moisture) and 10 g. of Desiccite

[a] This paper reports research undertaken in cooperation with the Quartermaster Food and Container Institute for the Armed Forces, and has been assigned number 589 in the series of papers approved for publication. The views or conclusions contained in this report are those of the authors. They are not to be construed as necessarily reflecting the views or indorsement of the Department of Defense.

[b] T = pounds moisture per pound of bone dry lima bean solids.

No. 30* in a permeable envelope was packed in each No. 1 tin can.

The dehydrated samples were stored at 70° and 100° F. Product evaluations were carried out initially and after 1½, 3, and 6 months.

Analytical and Evaluation Procedures

Samples of raw lima beans (about 1 lb. to the sample) were ground in an Osterizer and duplicate 10 g. samples were weighed for vacuum oven moisture determinations. These samples were pre-dried in an air oven at 80° C. for 5 hours and then placed in the vacuum oven for 6 hours at 95° C. under a pressure below 100 mm. Hg. Moisture determinations of dehydrated lima beans were made by grinding a sample in a Wiley mill equipped with a 20-mesh screen. Duplicate 3 g. samples were weighed and dried at 70° C. for 16 hours in the vacuum oven as described above.

The Potter and Hendel (5) modification of the sulfite determination by Prater *et al.* was used in these studies (3).

The procedure to determine the extent of rehydration of the dehydrated lima beans was similar to that previously employed in this laboratory (3). With this method the final rehydrated product served as the organoleptic sample. In this procedure 25 g. of dried lima beans was placed in a flask and 100 ml. of zeolite softened water plus 3.5 ml. of a saturated sodium chloride solution were added. After a 1½ hour soaking period at room temperature, the water was drained from the lima beans for 3 minutes and the beans weighed. The water and lima beans were then returned to the flask fitted with a glass joint type of condenser, and the assembly placed on an electric hot plate. The contents were allowed to simmer for 20 minutes, after which the weight of the beans was determined as before. Both the lima beans and liquid were transferred to white porcelain product pans for the organoleptic evaluation.

Organoleptic testing included the evaluation of 4 factors: flavor; off-flavor; color and appearance; and texture. These factors were scored on the basis of 1 to 10, with 5 being considered *acceptable*, 1 *very poor*, and 10 *excellent*. Flavor was taken to mean the normal lima bean taste and aroma, whereas off-flavor was used to designate the presence of sulfite, stale, hay-like or other anomalous flavors or odors. The factors were averaged and weighted as follows:

Flavor—Off-flavor, Averaged together × .5
Color and appearance × .3
Texture × .2

A final score of 5 indicated that the product was acceptable. Four to 6 testers were generally available for each organoleptic examination. The panel was composed of graduate students and staff members.

* Product of Filtrol Corporation, Los Angeles 17, California.

EXPERIMENTAL DESIGN

The experiment was designed to allow statistical evaluation of the results so that the maximum return on the research effort could be obtained. As shown in Table 1, it was a 6-factor split-plot factorial experiment. The factors studied included 2 blanch conditions, 3 sulfite treatments, 2 dehydration temperature schedules, 2 final moisture levels, 2 storage temperatures, and 4 storage periods.

Because the 3 batches representing the 3 levels of sulfite treatment were dehydrated at the same time, this design resulted in 4 dehydration runs. The design was replicated 4 times, so that 16 dehydration runs and 48 individual batches of dehydrated product were obtained. The order in which the various dehydration operations was performed was random. The position of the sulfited batch on the dehydration tray and the samples taken for a specific level of moisture content, storage temperature and storage time were likewise random. A total of 768 samples was evaluated in the course of the experiment.

RESULTS AND DISCUSSION

Preliminary studies. A number of preliminary experiments were performed so that the levels of each variable, e.g. concentrations of sulfite solution, could be chosen on a logical basis. These showed that sulfiting solutions having a pH below 7.0 caused the normal chlorophyll color to deteriorate. The damage increased as pH was reduced. Treatments with solutions having pH values above 7.0 did not have any visible effect on color.

Statistical treatment. It will be noted that only those values indicating significance at the 1% confidence level are starred in Table 2. That is the criterion used for all conclusions drawn from this experiment. It means that in only one trial (or less) out of 100 would such a result arise purely by chance. This practice was followed because it was felt that only those variables showing strong evidence of significance should be singled out and emphasized.

Maturity. A vacuum oven moisture determination was employed as the index of maturity of the raw lima beans. The moisture levels of the beans ranged from a low of 62.3% to a high of 69.4% among the 16 dehydration runs. The average moisture was 65.5%. Vacuum oven moisture was used in the analysis of covariance to determine the effect of maturity of the raw product on the various evaluation scores and tests.

TABLE 1
Dehydration of lima beans—(Clark's bush variety)
Maturity—(Considered on basis of analysis of covariance)

High Temperature Blanch								Low Temperature Blanch							
Sulfite								Sulfite							
None		Low		High				None		Low		High			
Dehydration Schedule								Dehydration Schedule							
High Temperature				Low Temperature				High Temperature				Low Temperature			
Moisture				Moisture				Moisture				Moisture			
High		Low		High		Low		High		Low		High		Low	
Storage		Storage		Storage		Storage		Storage		Storage		Storage		Storage	
70° F.	100° F.	70° F.	100° F.	70° F.	100° F.	70° F.	100° F.	70° F.	100° F.	70° F.	100° F.	70° F.	100° F.	70° F.	100° F.

Examinations 0 months
1½ months
3 months
6 months

Conditions
2 — Blanches
3 — Sulfite Treatments
2 — Dehydration conditions
2 — Moisture levels
2 — Storage temperatures

48 × 4 replications = 192
192 × 4 (storage times) = 768 total samples

TABLE 2

Analysis of variance effects of seven variables on the preparation and storage of dehydrated lima beans

Factor [3]	df	V.O.[2] moisture M.S.	Total water absorbed during rehydration M.S.	Flavor M.S.	Color M.S.	Texture M.S.	Off-flavor M.S.	Av. organoleptic M.S.
R	3	313	106	0.41	0.86	0.92	0.56	0.47
B, D, and BD	3	272	196	0.13	5.30	0.06	0.18	0.56
Error 1	9	180	426[1]	1.15	3.87[1]	2.13[1]	0.92	1.77[1]
S	2		1172[1]	33.50[1]	174.24[1]	24.77[1]	34.80[1]	56.61[1]
SX Misc.	6		64	0.87	0.53	0.25	0.75	0.34
Error 2	24		34	0.46	1.18	0.35	0.55	0.50
M	1		1373[1]	2.60	6.69	1.07	1.42	3.37
T	1		790	2.35	4.92	13.73	7.40	6.18
P	3		780	179.44	124.91	68.93	74.85	107.47
TP	3		286[1]	22.09[1]	9.87[1]	7.78[1]	6.96[1]	9.06[1]
Pooled remaining interactions	172		59[1]	1.02[1]	1.22[1]	0.78[1]	1.54[1]	0.70[1]
Pooled remaining errors 3, 4, and 5	540		23	0.29	0.32	0.27	0.35	0.17

[1] Significance at the 1% level.
[2] Vacuum oven moisture of raw material.
df Degrees of freedom.
M.S. Mean squares.
[3] Factors
R Replications
B Blanching condition
D Dehydration schedule
S Sulfiting treatment
M Moisture level in finished product
T Storage temperature
P Storage time

The results of the analysis of covariance showed that the moisture content of the raw product was not significantly related (i.e., at the 1% confidence level) to any of the various evaluation scores and tests, and that correction of the mean scores for initial raw moisture would not materially alter the mean values.

Replications. This experiment was replicated four times, but there was no significant difference among replications (Table 2). This means that the organoleptic testers gave very similar scores to each of the four samples having the same history of treatment, i.e. from the four replications. Thus, since the tester had no knowledge of what sample he was scoring, confidence in the organoleptic testing was greatly increased. Furthermore, this finding substantiated the validity of the experimental techniques used.

Blanching treatment. Preliminary work carried out prior to running this experiment seemed to indicate that lower blanching temperatures reduced the incidence of cracking and splitting of the beans during dehydration. Examination for cracking and splitting of all the samples of dehydrated beans did not show any definite advantage for either blanching treatment. The sampling problem for analysis of split and cracked beans was very difficult and variation within a single lot of product was very great. It was impossible, with the techniques employed, to show differences in cracking and splitting of the beans as a result of the different blanching treatments. But it should be pointed out that cracking and splitting of the dehydrated beans does not appear to be an extremely critical problem. Upon rehydration, the beans return to apparently normal condition and no damage is readily visible.

No significant difference was found between blanching treatments (Table 2). Neither blanching treatment was superior and apparently any blanching time and temperature treatment within these two extremes which will satisfactorily inactivate the peroxidase enzyme would be suitable for the blanching practice.

Dehydration schedule. No significant difference was found between the two initial dehydration schedules (Table 2). These initial dehydration treatments did not produce any significant effect on any of the organoleptic scores or in the total water absorbed during rehydration. Therefore, from a quality standpoint, neither initial dehydration schedule was superior.

From an operational standpoint, the high temperature dehydration schedule was very definitely superior. An average of 57 minutes was required to reduce the moisture content to T = 0.5 in the 8 dehydration runs using the high temperature dehydration schedule. The low temperature schedule, for a similar number of runs taken to the same moisture level, required an average of 102 minutes. This clearly shows a production cost advantage for the high temperature dehydration schedule which would be most desirable in a commercial operation.

Sulfite treatment. The sulfite treatment exerted a strong effect on all the various evaluation scores and values (Table 2). This finding is not surprising since sulfite exerts a powerful effect on general quality and acceptability of most dehydrated vegetables.

Table 3 presents the mean values for the various sulfite treatments. Examination of Tables 2 and 3 shows that sulfite exerted a very powerful effect on all organoleptic values and the total water absorbed during rehydration. All of these factors were significant at the 1% level.

Sulfite treatment is absolutely necessary in order to produce a highly acceptable product (Table 3). This is true for all organoleptic factors. Color is most seriously affected by elimination of sulfite treatment. A drab olive green color devoloped during dehydration and storage in the products not sulfited. Apparently development of the olive color is associated with increase in off-flavor and a decrease in natural lima bean flavor. Texture scores are also reduced in products not treated with sulfite. There seems to be a definite relationship

TABLE 3

Effect of sulfite treatment on the average organoleptic, sulfite and hydration values

Sulfite treatment	Total no. samples	Water absorbed during rehydration grams	Flavor	Color	Texture	Off-flavor	Weighted organoleptic	Sulfite p.p.m.
None	256	56.8	6.2	5.8	6.6	6.2	6.2	0
Low	256	59.5	6.9	6.9	7.0	6.9	6.9	449
High	256	61.1	6.9	7.4	7.2	6.6	7.0	2056

between the texture scores and the total water absorbed during rehydration. The sulfite treatment apparently promotes greater water absorption during rehydration.

The question regarding the optimum concentration of sulfite solution for preparation of lima beans for dehydration is not completely answered. The higher sulfite treatment (1.5% solution) produced the best colored product. However, these samples were scored down on off-flavor which, in this case, was due largely to a sulfite taste objectionable to some tasters. Apparently the specific sulfite treatment should be determined by the storage time and temperature under which the product will be held. Short storage periods at room or lower temperatures would not require a high level of sulfite. Apparently the 0.5% sulfite solution treatment which produced an average of about 450 p.p.m. of sulfur dioxide in the finished product would be most desirable if short storage times at room temperature or lower are to be used.

Moisture levels in the finished product. Total water absorbed during rehydration was the only variable significantly affected by moisture content of the final product (Table 2). Examination of the mean values in Table 4 shows a slight advantage for the organoleptic scores representing the low moisture samples. The low moisture levels were obtained by in-package desiccation. Although no significant advantage can be claimed for the in-package-desiccated samples, it appears that this practice favorably affected the product quality. But it must also be considered that if the high moisture samples had been reduced to below 5% moisture before packaging, perhaps not even a slight difference would be apparent.

The effect of moisture level caused a significant difference on the amount of water absorbed during rehydration (Tables 2 and 4). Dehydrated product reduced to lower moisture levels absorbed more water during rehydration. This generally agrees with findings for some other dehydrated vegetable products.

The average moisture values for the interaction of moisture level, storage temperature, and storage time are presented in Table 5. The mean for all low moisture samples was 4.12% while the mean for all high moisture samples was 6.59%. Storage temperature and storage time exerted no strong effect on the moisture levels in the in-package-desiccated product. Apparently the in-package-desiccant was quickly effective since the initial-examination moisture levels of the in-package-desiccated products were not markedly higher than the similarly treated 6-month examination samples.

TABLE 5

Average moisture values for interaction of moisture, storage temperature and storage time

Moisture level	Storage temperature	Storage period	Moisture content, percent
Low	Low	Initial	4.23
Low	Low	1½ mo.	4.22
Low	Low	3 mo.	4.16
Low	Low	6 mo.	3.95
Low	High	Initial	4.25
Low	High	1½ mo.	3.99
Low	High	3 mo.	4.19
Low	High	6 mo.	4.00
Average			4.12
High	Low	Initial	6.42
High	Low	1½ mo.	6.67
High	Low	3 mo.	6.74
High	Low	6 mo.	6.47
High	High	Initial	6.33
High	High	1½ mo.	6.63
High	High	3 mo.	6.79
High	High	6 mo.	6.63
Average			6.59

Interaction of storage temperature and storage time. The factors of storage temperature and storage time generally affect the acceptability of dehydrated foods to a marked degree. This effect has been demonstrated by many workers and in our own laboratory with dehydrated sweet corn *(3, 4)*. All the organoleptic values as well as the total water absorbed during rehydration were significant at the 1% level for the interaction of storage temperature and storage time (Table 2). The mean scores representing the single effects of storage temperature and storage time as well as the interaction of storage temperature and storage time are presented in Table 6. Average sulfite level was affected to a lesser degree by storage temperature than by storage time. Storage time causes a definite reduction in the sulfite level during 6 months' storage. However, storage temperature in the two ranges studied, 70° F. and 100° F., appeared to exert little if any effect on the average sulfite levels during the storage period. Perhaps higher

TABLE 4

Effect of moisture level on the average organoleptic, sulfite and hydration values

Moisture level	Total no. samples	Water absorbed during rehydration grams	Flavor	Color	Texture	Off flavor	Weighted organoleptic	Sulfite p.p.m.
Low	384	60.4	6.7	6.8	7.0	6.6	6.8	863
High	384	57.8	6.6	6.6	6.9	6.5	6.6	807

TABLE 6

Effect of the combination of storage temperature and storage time on the average organoleptic, sulfite and hydration values

Storage temp. x (° F.)	Storage time (months)	Total no samples	Water absorbed during rehydration (grams)	Flavor	Color	Texture	Off flavor	Weighted organoleptic	Sulfite (p.p.m.)
70	0	96	60.3	7.3	7.2	7.2	7.0	7.2	917
70	1½	96	60.6	6.8	6.9	7.3	6.6	6.9	815
70	3	96	58.9	6.6	6.8	7.2	6.6	6.8	872
70	6	96	60.7	6.1	6.5	6.6	6.4	6.5	748
100	0	96	60.6	7.2	7.2	7.1	7.0	7.1	932
100	1½	96	59.0	7.1	7.0	7.2	6.7	7.0	858
100	3	96	56.2	6.0	6.3	6.6	6.1	6.3	831
100	6	96	57.1	6.1	6.0	6.3	6.0	6.1	705

storage temperatures would show more definite effects on the sulfite levels.

The most important consideration in regard to effects of storage temperature and storage time is the very obvious fact that dehydrated lima beans are quite stable during storage. Although storage temperature and storage time caused a definite and gradual reduction in quality during 6 months' storage, the final products were very acceptable. It appears that dehydrated lima beans were definitely more stable than dehydrated sweet corn during six months' storage *(3, 4)*. High storage temperature (100° F.) did not reduce the acceptability of dehydrated lima beans as much as it did in the case of dehydrated sweet corn. It is also apparent that dehydrated lima beans compare favorably, as regards storage stability, with the most stable of dehydrated vegetables.

SUMMARY AND CONCLUSIONS

A six factor split-plot factorial experiment, replicated four times, was developed for this study on lima bean dehydration. A statistical variance analysis of the organoleptic scores and objective values was made. Analysis of covariance showed that maturity, as measured by vacuum oven moisture content, was not significantly related to any of the various evaluation scores and values. Therefore, it can be concluded that the effect of maturity of the raw product within the limits of variation in this experiment was of minor influence on the acceptability of the finished product.

No significant difference was observed among the four replications which markedly strengthens the confidence in the experimental techniques used.

Blanching treatment and dehydration schedules, within the limits studied, did not produce a significant effect on the finished product. However, the high temperature dehydration schedule required about 50% less time and would be more desirable from a production standpoint.

Sulfite treatment produced a highly significant effect. Sulfiting of lima beans during preparation for dehydration is necessary to preserve color, flavor, texture and total hydration characteristics. Color of the finished product was especially stabilized by treating the blanched beans in a 1.5% sulfite solution of pH 7.2. If the dehydrated product is to be held for long periods of time or at high temperatures, the 1.5% sulfite solution treatment should be employed.

No highly significant advantage was found for the dehydrated lima beans in which in-package-desiccants were used, but some slight advantage in storage stability might be gained by reducing the moisture of the dehydrated lima beans to about 5% prior to packaging.

Storage temperature and storage time exerted significant effects on the finished product quality and even though lima beans appear to be very stable as dehydrated products, attention to these factors, as with other dehydrated food products, will increase the storage life.

From the results of this study it is recommended that shelled lima beans be thoroughly cleaned and washed, blanched 3 minutes in water at 210° F., treated with 1.5% sulfite solution, initially dehydrated in a through-flow atmospheric drier using the high temperature dehydration schedule to a T value of 0.5, finish-dried to a moisture content of about 5% and the product vacuum packed in plain tin cans.

Acknowledgment

The authors thank Professor Walter Huelson for aid in procuring the raw material for this study. They also acknowledge the capable assistance of J. N. McGill for aid in the preparation, evaluation, and analysis of samples.

LITERATURE CITED

1. Brown, H. D., Peters, G., and Gould, W. A. Evaluation of lima bean varieties for dehydration. Ohio Agricultural Experiment Station *Research Bulletin 751* (1954).
2. Caldwell, J. G., Culpepper, C. W., Hutchins, M. C., Ezell, B. D., and Wilcox, M. S. Suitability for dehydration of nineteen varieties of lima beans. *Fruit Products J. and Am. Food Manuf.*, **25** (2) 39-46; 59 (1945).
3. Nelson, A. I., Kempe, L. L., Norton, H. W., and Howard, L. B. Studies on the dehydration of sweet corn. *Food Technol.*, **8**, 9-14 (1954).
4. Nelson, A. I., Steinberg, M. P., Legault, R. R., Norton, H. W., and Fritzsche, H. A comparison of through-air-flow and cross-air-flow methods for the initial dehydration of sweet corn. *Food Technol.*, **9**, 254-259 (1955).
5. Potter, E. F., and Hendel, C. E. Determination of sulfite in dehydrated white potatoes by direct titration. *Food Technol.*, **5**, 473-475 (1951).

Effect of Temperature and Moisture on Storage Stability of Vacuum-Dried Tomato Juice Powder

FRANCIS F. WONG, WILLIAM C. DIETRICH, JEAN G. HARRIS AND F. E. LINDQUIST

Western Utilization Research Branch, Agricultural Research Service, United States Department of Agriculture, Albany 10, California

(Manuscript received September 12, 1955)

The stability of a vacuum-dried tomato-juice powder stored at various temperatures under a variety of packaging conditions has been investigated by analytical and subjective-appraisal methods. In-package desiccation used with an inert atmosphere appears to be the most favorable packaging procedure. Air-packing is less desirable because of adverse flavor and color changes. Nonenzymatic browning and ascorbic acid content are most affected by increased moisture and higher storage temperatures. Visible color changes have not been excessive but appear to be most evident in air-packed material. A small consumer-type panel survey on a limited number of samples stored for one year indicates a high degree of acceptability for the product.

The trend toward the preparation of foods in concentrated form with resultant advantages in storage and shipping economy has led to the development of processes for the preparation of high-quality fruit juice powders. Strashun and Talburt *(12a, b)* have discussed the preparation of powders from several commodities by a puff-drying process. Mylne and Seamans *(9)* reported that orange-juice powder prepared by this method showed a remarkable stability at storage temperatures as high as 100° F. (37.7° C.). The successes with fruit-juice powders have prompted similar research on tomato juice. Kaufman *et al. (4)* described methods for preparation of tomato-juice powder by vacuum drying, while Lazar *et al. (5)* have investigated spray drying. Recent studies have indicated that application of vacuum-drying methods to continuous-type dehydrating equipment is feasible *(14)*.

One of the basic requirements for new food products is adequate shelf-life or storage stability. Such considerations prompted the work described in this communication.

PREPARATION AND STORAGE OF SAMPLES

A preliminary investigation *(6)* with tomato powder prepared by drying serum and pulp separately as described by Kaufman *et al. (4)* supplied data used to plan this storage study. The powder used was prepared by the direct drying method *(4)* from a paste obtained by concentrating a high-quality tomato juice at reduced pressure to 36° Brix, in order to avoid heat damage. The product temperature during concentration never exceeded 85° F. (29.4° C.). The paste was aerated by mixing in a planetary-type mixer, spread on stainless-steel tray at a loading rate of 0.5 lb. per sq. ft., and dried in a vacuum-shelf drier at pressures below 2 mm. Hg until the moisture content was reduced to about 2.5%. Product temperature during dehydration did not exceed 150° F. (65.6° C.).

All post-dehydration handling of the powder was carried out in a room at 5 to 6% relative humidity. Each lot of puff-dried material was coarsely ground to pass through 14- to 16-mesh screens. The total production of powder was blended and packaged in 6-oz. (202 x 314) sanitary-type cans, 53 g. per can. When required as a packaging variable, a vacuum of 30 in. Hg was applied. Nitrogen packing was accomplished by evacuating and flushing with nitrogen so as to reduce the oxygen content within the containers to 0.5%. Where in-package desiccation, discussed in detail by Talburt *et al. (13)*, was a variable, the desiccant was inserted in the cans in the manner described by Strashun and Talburt *(12b)* prior to filling. The desiccant units consisted of 10 g. of calcined lime enclosed in a heat-sealed packet formed from double-creped kraft paper.

Seven packaging variables were used in the main study and samples were stored at 70° F. (21.1° C.), 90° F. (32.2° C.), and 100° F. (37.7° C.) as indicated in Table 1. All sample groups

TABLE 1
Packaging Variables and Storage Temperatures for Tomato Powder

Atmosphere	Storage temperature				
	70° F. (21.1° C.)		90° F. (32.2° C.)		100° F. (37.7° C.)
	Desiccant	No-Desiccant	Desiccant	No-Desiccant	Desiccant
Air	+	+	+	—	+
Air, Sulfited	+	—	+	—	+
Nitrogen	+	+	+	+	+
Vacuum	—	+	+	+	+
Carbon Dioxide	+	—	—	—	+
Air-Albumen	—	—	—	—	+

None without Desiccant

were kept at 37° F. (2.8° C.) for one week prior to the initiation of the storage tests. During this time, the necessary samples were nitrogen-packed following initial air packing. In addition, a few CO_2-desiccant pack samples (cf. N_2 pack) were placed in storage at 70° and 100° F. and a limited number of air-desiccant-packed powders containing 0.25% albumen were stored at 100° F. Control material was nitrogen-packed and stored at −10° F. (−24.4° C.).

Certain samples of the packaging variables were purposely added or omitted from storage at the different temperatures to reduce the number of samples. The decisions were arrived at after evaluation of earlier observations *(6)*, which were as follows: (a) No appreciable difference was shown between nitrogen- and vacuum-packed samples stored for 6 months at 70° F. (21.1° C.) without desiccant. Since further study of packs with desiccants was desired, the vacuum pack without desiccant was eliminated on the assumption that changes which might occur in this pack would be reflected closely in changes which would be noted in the corresponding nitrogen pack. (b) The air sample without desiccant was eliminated from 90° F. storage variable, since samples packed in this manner showed a highly significant change after 6 weeks' storage at 100° F. It was felt that similar changes would most probably occur in such samples stored at 90° F. for 3 months. However, the vacuum-packed sample without desiccant was included in the 90° F. series to make possible comparisons of nitrogen and vacuum packs both with and without desiccant at this temperature. (c) All samples without desiccant were omitted from the 100° F. series, since previous data showed a significant lowering of flavor quality in all materials containing about 2.5% moisture packed without desiccant, regardless of packaging atmosphere.

Samples were examined by selected chemical analyses and evaluated by panel appraisal after 6 weeks, 3, 6, and 12 months of storage. Moisture analyses on the desiccated samples and

ascorbic acid analyses on all samples of the 90° F. and 100° F. series were made at more frequent intervals. Samples were not held at room temperature to permit reduction of moisture content before placing at elevated storage temperatures, since earlier work had shown little advantage from this procedure *(6)*.

METHODS AND RESULTS OF CHEMICAL ANALYSES

Moisture (total solids). Moisture was determined by drying the powder sample under a 30-inch vacuum at 70° C. for 7 hours. This procedure was adopted after tests indicated comparable results with the Karl Fischer method *(8)*.

Ascorbic acid. Ascorbic acid determinations were carried out by a variation of the method of Loeffler and Ponting *(7)* as described by Ponting *(10)*.

Soluble color. The extent of nonenzymatic browning was determined by a modification of the procedure developed by Hendel *et al. (3)*. The measurements were made on 2.5% aqueous extracts of the powders after clarification. A photoelectric colorimeter using the regular cylindrical tubes (approximately 2 cm. in diameter) and fitted with a 420 mμ filter was employed. The results were expressed as optical density, $E^{2.5\%}_{2\,cm.}$ 420 mμ.

Gas analyses. Analyses of atmospheres in cans of selected air- and gas-packed samples were made with a modified Orsat gas analyzer. Results of the analyses are shown in Table 2. So strikingly similar were the data obtained from the desiccated samples in inert atmospheres (N_2, CO_2, vacuum) that only results for the N_2-desiccated samples are presented.

Initial moisture content was assumed to be that of the control samples (N_2, —10° F.). The range of 2.7 to 2.9% is within the experimental error of the method. In general, the samples stored at 70° F. without desiccant did not show any significant changes in composition during the storage period. A slight increase in moisture content was found in corresponding samples stored at 90° F., and is attributed to decomposition of the samples as is further evidenced by the presence of increasing amounts of CO_2 in the can atmospheres.

The effects of in-package desiccation was very apparent. A general decrease in moisture was observed with increasing storage time. These changes were most pronounced during the first 3 months and were markedly accelerated at the higher storage temperatures. Rates of moisture reduction during storage are illustrated in Figure 1. As expected, the most rapid changes were observed in samples stored at 100° F., the moisture level dropping to 1.4%, one-half the original, after the first week, and to slightly less than 0.7% by the end of 6 weeks. This decrease continued at a more gradual rate, reaching an apparent minimum (0.1 to 0.2%) between 6 and 7 months. The moisture then increased slightly and remained at the 0.25% level for the duration of storage.

Correspondingly, the changes at the milder storage temperature of 90° F. were less rapid; the moisture levels were 1.0 and 0.6% after 6 weeks and 3 months, respectively. An apparent minimum (0.4%) was reached at the end of 6 months, and this moisture level remained essentially unchanged after 12 months.

Following an initial drop to 1.8% after 6 weeks, the change in moisture level in samples stored at 70° F.

TABLE 2
Analyses of Stored Vacuum-Dried Tomato Powder

Analysis	% Moisture						Ascorbic acid [1]						Soluble color [2]						Composition of can atmosphere [3]									
Storage condition	N_2, no desiccant	N_2, desiccant	Vacuum, no desiccant	Air, no desiccant	Air, desiccant	Air, desiccant, SO_2	N_2, no desiccant	N_2, desiccant	Vacuum, no desiccant	Air, no desiccant	Air, desiccant	Air, desiccant, SO_2	N_2, no desiccant	N_2, desiccant	Vacuum, no desiccant	Air, no desiccant	Air, desiccant	Air, desiccant, SO_2	N_2, No desiccant		N_2, desiccant		Air, No desiccant		Air, desiccant		Air, desiccant, SO_2	
																			O_2	CO_2	O_2	CO_2	O_2	CO_2	O_2	CO_2	O_2	CO_2
70° F. (21.1° C.)																												
6 weeks	2.6	1.9	....	2.7	2.0	1.7	15.3	15.1	....	15.2	15.6	16.5	0.20	0.23	....	0.22	0.22	0.19	0.2	0	0.1	0	18.5	0.1	17.4	0	17.4	0
3 months	2.6	1.6	....	2.6	1.5	1.5	14.8	15.1	....	14.8	15.0	15.7	0.20	....	....	0.21	0.22	0.18	0.2	0	0.4	0.2	17.0	0.4	16.5	0.1	16.1	0.2
6 months	2.9	1.5	....	2.9	1.4	1.3	14.9	14.9	....	15.0	15.2	16.2	0.20	0.20	....	0.20	0.22	0.22	0	0.1	0.3	0	17.3	0.3	15.3	0	15.5	0
12 months	2.9	1.0	....	3.0	1.1	1.0	15.1	15.3	....	15.3	14.7	15.1	0.16	0.22	....	0.21	0.22	0.20	0.1	0.1	0.1	0	15.6	0.5	14.2	0.1	14.1	0
90° F. (32.2° C.)																												
6 weeks	2.8	1.1	2.9	....	0.9	1.0	14.2	15.3	14.6	....	15.1	15.8	0.24	0.22	0.23	....	0.21		0.4	0.4	0	0	....	....	17.1	0	17.0	0.1
3 months	3.2	0.5	2.9	....	0.6	0.6	12.9	14.8	13.4	....	15.2	16.1	....	0.22	0.26	....	0.20		0.4	1.1	0.2	0.1	....	....	15.8	0	15.8	0.2
6 months	3.3	0.4	3.1	....	0.4	0.4	....	15.1	10.7	....	14.5	15.5	0.30	0.21	0.33	....	0.20		0.4	2.0	0.2	0.1	....	....	14.2	0	14.4	0.1
12 months	3.4	0.5	3.5	....	0.3	0.4	6.6	14.9	7.2	....	15.1	15.1	0.58	0.22	0.55	....	0.23		0	6.4	0.4	0.1	....	....	12.6	0.2	12.0	0
100° F. (37.7° C.)																												
6 weeks	....	0.7	....	....	0.7	0.7	....	15.2	....	....	15.3	16.2	....	0.22	....	....	0.23		....	....	0	0	....	....	16.4	0	16.0	0
3 months	....	0.3	....	....	0.5	0.5	....	15.4	....	....	14.9	15.9	....	0.24	....	....	0.24		....	....	0.1	0.1	....	....	15.2	0.1	15.4	0.1
6 months	....	0.1	....	....	0.1	0.2	....	15.1	....	....	14.9	15.6	....	0.21	....	....	0.22		....	....	0.3	0.3	....	....	11.5	0.2	13.2	0
12 months	....	0.3	....	....	0.3	0.3	....	15.2	....	....	14.8	15.6	....	0.26	....	....	0.24		....	....	0.2	0.2	....	....	11.6	0	10.6	0

[1] mg. AA/100 g. reconstituted juice (6.5° Brix).
[2] Optical density = 2 — log G.
[3] Percent N_2 by difference.

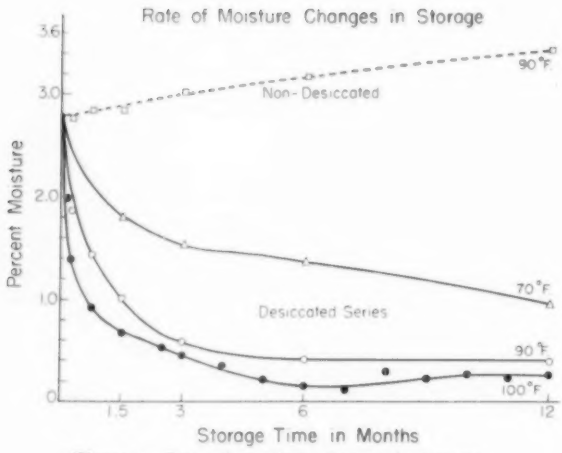


Figure 1. Rate of moisture changes in storage.

was less pronounced, being 1.5% at 3 months and gradually decreasing to 1.0% at 12 months.

The effect of high-temperature storage on the deterioration of ascorbic acid in non-desiccated powders was very pronounced. At the end of 12 months, samples stored at 90° F. had lost two-thirds of the ascorbic acid originally present. On the other hand, similar material stored at 70° F. for the same period showed no significant change in the ascorbic acid content. This is in agreement with earlier observations that regardless of the packaging atmosphere, non-desiccated material stored at 100° F. showed comparable losses after 6 months, while the changes at 70° F. were found to be negligible. Contrariwise, the ascorbic acid levels of all desiccated samples were essentially unchanged after 12 months. The average values of the N_2-desiccant samples, for example, were not significantly different from those of the control sample.

Results of the soluble color analyses—an index of nonenzymatic browning or heat damage—indicate a trend similar to the ascorbic acid in that the desiccated material showed a significant lack of color development regardless of packaging atmosphere or storage environment. Moreover, the nondesiccated samples stored at 70° F. did not show evidence of change. At 90° F., however, the soluble color of nondesiccated samples did show marked increases with increasing length of storage.

Gas analyses of air-packed samples showed a continuing loss of oxygen on storage. The most marked change was noted at higher temperatures. Slight increases in CO_2 were found in nondesiccated air- or N_2-packed samples with increasing length of storage at 70° F. These changes were very pronounced at 90° F. and indicate deteriorative changes in the samples. The flavor ranks in Table 3 indicate some deteriorative changes in the desiccant-packed samples, but any carbon dioxide formed appeared to have been removed by the desiccant.

METHODS AND RESULTS OF SUBJECTIVE APPRAISAL

Subjective appraisals of the tomato powders were made after storage of 6 weeks, 3, 6, and 12 months. They were reconstituted to a juice of 6.5° Brix and evaluated for both flavor and color by a panel of 10 to 12 trained judges. Juices were chilled to 40° F. (4.4° C.) before serving. All 7-sample series (see table of results) were appraised for flavor by a balanced incomplete block design, plan 11.8 of Cochran and Cox *(1)*. This plan provides for 7 taste sessions of 4 samples each making possible 4 replications of each sample. With the 5-sample series (see table) a similar design was used requiring, however, only 5 taste sessions. A labeled control, nitrogen-packed, and stored at —10° F. (—24.4° C.), was served as a reference at each tasting session. A coded "hidden" control of the same material was used in the appraisal of every series with the exceptions of the 70° F. (21.1° C.) series at 6 and 12 months. In these series, coded controls were left out to permit the judging of an extra variable.

For the appraisal of color, all the samples of a series were presented together and evaluated in a special booth with a neutral background and illuminated by a daylight lamp. Labeled and coded controls were used, and 3 replications of each series were made. Fresh samples of juice were presented each time in 50-ml. crystallizing dishes filled to the brim.

The ranking of samples was made on the similarity of flavor or color to the labeled control. Rank 1 was given to the sample with flavor most like the control. Comparative lightness and darkness were the only color considerations evaluated by the panel. Rank 1 was given to the darkest (red) sample in each series. Determination of lycopene content, as well as color changes by use of the Hunter[a]-color difference meter, were also made, but these results are not presented in this study.

Statistical analyses of each judge's rankings in regard to treatment, effect, and replications were carried out in the manner discussed by Wood *et al. (15)*. Least significant differences (LSD) were calculated by the Scheffé method *(11)*.

Results of the flavor appraisal presented in Table 3 indicate that a combination of in-package desiccation with inert atmosphere gives the most protection to flavor. After 12 months, all samples stored under these conditions were still reasonably good, although the development of off-flavors was apparent. These changes become progressively more pronounced as the temperature of storage is increased from 70° F. (21.1° C.) through 90° F. (32.2° C.) and 100° F. (37.7° C.), and are characterized as "hay or grassy," "some scorch and grassiness," and "much scorch or oxidized," respectively. After 12 months of storage at 100° F. no one packaging atmosphere showed any particular advantage, since all samples in this series were ranked equally lower than the controls. However, at 70° F. and 90° F., inert gas and vacuum packing plus desiccation were ranked as being considerably better than corresponding air-packed samples. Grassy and oxidative off-flavors were perceptible in all air-packed samples as early as 6 weeks and continued to develop throughout the storage periods.

[a] Mention of specific products does not imply endorsement by the Department of Agriculture over others of a similar nature not mentioned.

TABLE 3

Influences of Packaging Conditions During Storage on Tomato Powder Flavor Rankings by Trained Judges [1]

Storage time and temp. (except control)	Control N_2-10° F.	Vacuum, desiccant	N_2, desiccant	CO_2, desiccant	Nitrogen, no desiccant	Air, desiccant	Air, desiccant SO_2	Air, no desiccant	Vacuum, no desiccant	Air, desiccant, albumen	L.S.D.[2] at .05
6 Weeks:											
70° F.	2.96	2.44	2.36		5.44[3]	6.20[3]	4.40	4.20			1.54
90° F.	3.78	3.00	3.44		3.78	6.78[3]	4.72[3]		3.50		1.66
100° F.	3.80	3.36	3.50	2.76		6.04[3]	5.04[3]			5.70[3]	1.58
3 Months:											
70° F.	2.70	1.96	2.76		3.24	6.80[3]	5.56[3]	5.04[3]			1.24
90° F.	1.64	3.20[3]	3.00		4.24[3]	6.16[3]	5.00[3]		4.80[3]		1.56
100° F.	2.10	3.84[3]	3.44	3.20		5.90[3]	4.70[3]			4.80[3]	1.70
6 Months:											
70° F.		2.44	2.36	2.16	3.50[3]	6.60[3]	5.50[3]	5.44[3]			1.30
90° F.	1.56	2.84[3]	3.16[3]		4.76[3]	5.80[3]	5.24[3]		4.64[3]		.54
100° F.	1.93	3.36[3]	3.00[3]			4.15[3]	2.55				.75
12 Months:											
70° F.		2.30	2.50	2.56	3.20	6.76[3]	4.96[3]	5.76[3]			1.20
90° F.	2.00	3.12	2.84		5.34[3]	5.56[3]	4.34[3]		4.84[3]		1.68
100° F.	1.56	3.00[3]	3.26[3]			3.82[3]	3.33[3]				.96

[1] Samples in each row across judged together with N_2 —10° F. sample as labeled control. Rank 1 = flavor most like control. Rank 7 (or Rank 5 with 100° samples after 3 mo.) = flavor most different from control. Flavor ranks converted from scale of 1-4 to scale of 1-7 (1-5 with 100° samples) to be comparable to color ranks.

[2] Least significant difference by Scheffé method (*11*).

[3] Significantly different from control at 5% level (different from lowest ranked sample in series having no hidden control).

TABLE 4

Influences of Packaging Conditions During Storage on Tomato Powder Color Rankings by Trained Judges [1]

Storage time and temp. (except control)	Control N_2-10° F.	Vacuum, desiccant	N_2, desiccant	CO_2, desiccant	Nitrogen, no desiccant	Air, desiccant	Air, desiccant SO_2	Air, no desiccant	Vacuum, no desiccant	Air, desiccant, albumen	L.S.D.[2] at .05
6 Weeks:											
70° F.	3.31	2.79	3.09		3.02	4.74[3]	5.90[3]	5.15[3]			1.23
90° F.	4.10	2.92[3]	3.92		2.93[3]	6.18[3]	6.05[3]		1.89[3]		1.08
100° F.	3.69	2.56	4.13	2.60		4.74	5.05[3]			5.13[3]	1.34
3 Months:											
70° F.	3.15	2.31[3]	1.80[3]		3.59	6.21[3]	6.31[3]	4.64[3]			.84
90° F.	3.97	2.36[3]	3.74		3.05	6.70[3]	6.05[3]		2.23[3]		1.07
100° F.	3.28	1.77[3]	3.05	2.67		5.85[3]	5.20[3]			6.18[3]	1.06
6 Months:											
70° F.		2.21	2.79	2.67	2.85	5.76[3]	6.12[3]	5.61[3]			1.16
90° F.	3.72	2.94	4.03		2.19[3]	6.61[3]	6.08[3]		2.42[3]		.92
100° F.	2.42	2.19	2.22			4.17[3]	4.00[3]				.68
12 Months:											
70° F.		2.07	2.71	2.90	2.70	6.30[3]	5.93[3]	5.37[3]			1.15
90° F.	4.33	3.07[3]	3.70		2.15[3]	6.37[3]	6.26[3]		2.11[3]		1.19
100° F.	2.17	2.07	1.77			4.53[3]	4.47[3]				.56

[1] Samples in each row across judged together with N_2 —10° F. sample as labeled control. Rank 1 = darkest color. Rank 7 (or Rank 5 with 100° samples after 3 mo.) = lightest color.

[2] Least significant difference by Scheffé method (*11*).

[3] Significantly different from control at 5% level (different from lowest ranked sample in series having no hidden control).

The intensity of off-flavor varied directly with increasing temperature and length of storage. The addition of sulfite to the product appears to afford some protection; however, the extent of this effect cannot be deduced from these experiments. The samples containing albumen as a drying aid were ranked with other air-packed samples after 6 weeks and 3 months. Since the contributive effect of the added albumen to storage stability could not be deduced, further study of this pack was omitted.

Results of the color appraisal (Table 4) indicate small but detectable changes. In general, all air-packed samples show a lightening of the red tomato color regardless of the storage temperature. The colors of all other samples were rated similar to or darker red than the controls. These differences between the air and inert atmosphere packs were consistent and developed throughout the storage period. They also appear to be little affected by desiccation.

Cross comparisons of the N_2-desiccant-packed samples were made after 6 weeks, 3 and 6 months. Control samples, again, were N_2-packed and stored at —10° F. The results are presented in Table 5. These data indicate the adverse effect of temperature with increasing length of storage. Cross comparison at 12 months was not made, since these results can be predicted to be similar to those observed at 6 months. The air-desiccant-packed sulfited sample was included in the 6-months

TABLE 5

Influence of Storage Temperature of Nitrogen-Desiccant Packed Tomato Powder on Flavor and Color Rankings (Trained Judges)

Storage time	Control N_2 10° F.	N_2 desiccant 70° F.	N_2 desiccant 90° F.	N_2 desiccant 100° F.	Air-desiccant SO_2 100° F.	L.S.D.[2] at 5%
Flavor Rankings [1]						
6 weeks	2.00	2.02	2.32	3.65[3]		.58
3 months	1.58	1.78	2.78[3]	3.88[3]		.48
6 months	1.83	1.85	2.98[3]	4.17[3]	4.17[3]	.60
Color Rankings [1]						
6 weeks	2.35	2.71	2.43	2.31		NS[4]
3 months	2.63	2.65	2.47	2.27		NS
6 months	2.14	3.00[3]	2.56	2.42	4.89[3]	.74

[1] Samples in each row across judged together with N_2 —10° F. Sample as labeled control. Rank = flavor most like control, darkest color. Rank 4 or 5 = flavor most different from control, lightest color.

[2] Least significant difference by Scheffé method (*11*).

[3] Significantly different from control at 5% level.

[4] NS = No significant difference.

cross comparison because it was unexpectedly ranked like the control in the general appraisal (see Table 3). In the cross-comparison, however, this air-desiccant-packed sulfited sample was ranked below all others except the N_2-desiccant sample stored at 100° F. with which it received an equal rank.

Since the reactions of a panel of trained judges do not necessarily reflect consumer reaction, a small acceptability study was made on the following 12-month samples: vacuum-desiccant pack stored at 70° F. and 100° F. and N_2-desiccant pack stored at 100° F. Twenty-five persons with no previous tasting experience rated each sample on a 9-point preferability scale ranging from *like extremely* to *dislike extremely*. A different group was selected to rate each sample, since it has been found that in consumer-type panels, one sample may greatly influence the judgment of the following one (*2*). In these tests, each person tasted the same juice in the morning and again in the afternoon. The results, presented in Figure 2, indicate a high

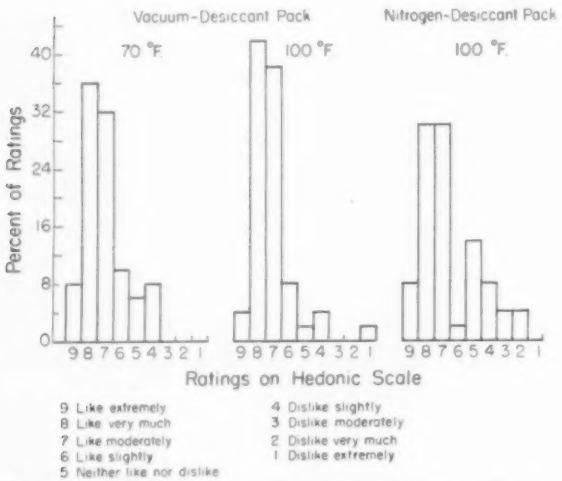


Figure 2. Acceptability of some samples stored for 12 months.

degree of acceptability of all samples tasted. It should be borne in mind that these samples were not compared with any other and hence the results do not reflect changes during storage discussed above.

SUMMARY

The results reveal that vacuum-dried tomato-juice powder when properly packaged can be stored at temperatures as high as 90° F. for 12 months without serious loss of quality. Storage at 100° F. for this length of time produced off-flavors in all packaging variables investigated. However, juices made by reconstituting some of these powders with water have been rated high in acceptability by panels of tasters.

Temperature of storage, package atmosphere, and moisture content are important factors in the storage stability of the product. Moisture contents near 2.5% or possibly slightly higher were found tolerable at a storage temperature of 70° F. However, at 90° and 100° F. it is necessary, in addition to storing in an inert atmosphere, to lower the moisture content of the samples. Sufficient reduction was accomplished with an in-package desiccant to prevent untoward changes in flavor and ascorbic acid content and to repress nonenzymatic browning.

Acknowledgment

The authors wish to express their appreciation to D. H. Taylor, G. K. Notter, E. Breitwieser, E. C. Marshall, H. J. Neumann, and G. O. Turner of this Branch and to Ivor T. Nii of the Quartermaster Food and Container Institute for the Armed Forces for their assistance in preparing the storage material and samples, and also to Nell Anderson and Delpha Venstrom for their assistance in the appraisal of the samples.

LITERATURE CITED

1. Cochran, W. G., and Cox, G. M. *Experimental Designs.* 1950, John Wiley & Sons, N. Y.
2. Hanson, H. L., Davis, J. G., Campbell, A. A., Anderson, J. H., and Lineweaver, Hans. Sensory test methods. II. Effect of previous tests on consumer response to foods. *Food Technol.*, **9**, 56 (1955).
3. Hendel, C. E., Bailey, G. F., and Taylor, D. H. Measurement of nonenzymatic browning of dehydrated vegetables during storage. *Food Technol.*, **4**, 344 (1950).
4. Kaufman, V. F., Wong, F. F., Taylor, D. H., and Talburt, W. F. Problems in the production of tomato juice powder by vacuum. *Food Technol.*, **9**, 120 (1955).
5. Lazar, M. E., Brown, A. H., Smith, G. S., Wong, F. F., and Lindquist, F. E. Experimental production of tomato powder by spray drying. (Submitted to *Food Technology.*)
6. Lindquist, F. E., Dietrich, W. C., Harris, J. G., and Olcott, H. S. Storage stability of tomato juice powder. Presented at IFT meeting, Los Angeles, Calif., June, 1954. *Food Technol.*, **8** (supplement) (abstract) (May 1954).
7. Loeffler, H. J., and Ponting, J. D. Ascorbic acid. Rapid determination in fresh, frozen, or dehydrated fruits and vegetables. *Ind. Eng. Chem., Anal. Ed.*, **14**, 846 (1942).
8. McComb, E. A., and Wright, H. M. Application of formamide as an extraction solvent with Karl Fischer reagent for the determination of moisture in some food products. *Food Technol.*, **8**, 73 (1954).
9. Mylne, A. M., and Seamans, V. S. Stabilized orange juice powder. II. Changes during storage. *Food Technol.*, **8**, 45 (1954).
10. Ponting, J. D. Extraction of ascorbic acid from plant materials. Relative suitability of various acids. *Ind. Eng. Chem., Anal. Ed.*, **15**, 389 (1943).
11. Scheffé, H. A method for judging all contrasts in the analysis of variance. *Biometrika*, **40** (1-2), 87 (1953).
12. Strashun, S. I., and Talburt, W. F. (a) WRRL develops techniques for making puffed powder from juice. *Food Engin.*, **25** (3), 59 (March, 1953). (b) Stabilized orange powder. I. Preparation and Packaging. *Food Technol.*, **8**, 40 (1954).
13. Talburt, W. F., Hendel, C. E., and Legault, R. R. Desiccating in the package. *Food Engin.*, **26** (4), 79 (1954).
14. U. S. Department of Agriculture, Western Utilization Research Branch (Albany, Calif.). Continuous process proves successful for puffed tomato powder. Released May 18, 1955. *Western Canner and Packer*, **47** (7), 16 (1955) and other journals.
15. Wood, E. R., Jeeves, T. A., Nutting, M. D., Debeau, B. P., and Burr, H. K. Application of statistical procedure to ranking of seven tomato juice samples. (In preparation, Western Utilization Research Branch, U. S. Department of Agriculture.)

Freeze Curing of Bacon

BETTY M. WATTS

Department of Food and Nutrition, The Florida State University, Tallahassee, Florida

(Manuscript received October 7, 1955)

Dipping sliced raw pork into curing brines containing sodium chloride, sodium nitrite, sodium ascorbate and liquid smoke and then freezing results in an excellent bacon-like product. The ascorbate and smoke prevents the development of rancidity.

It has previously been shown *(4, 5)* that the cured meat pigment, nitric oide hemoglobin or myoglobin, can be formed by freezing either hemoglobin solutions or ground meat containing ascorbic acid and nitrite. The initial change which takes place when the ascorbic acid and nitrite are mixed with the ground meat is a browning attributed to the reaction of nitrite with oxymyoglobin to give metmyoglobin. If the meat is frozen at this stage, the bright pink color of nitric oxide myoglobin develops after approximately three or four days in the freezer and is stable over many months. The ascorbic acid is essential to early and complete development of the cured meat color; without it the pink color develops only partially and after many weeks in the freezer.

On the other hand, the ascorbic acid does not consistently protect fat from oxidation. In fact, ascorbic acid may either retard or accelerate rancidity. In the majority of experiments on frozen meats performed in our laboratory it has accelerated rancidity, sometimes very markedly. However, a combination of ascorbic acid and certain commercial smoke flavors or "liquid smokes" invariably acted as a powerful antioxidant, even though the ascorbic acid alone might be accelerating rancidity *(3)*.

These two functions of ascorbic acid in the curing process, i.e. its ability to produce nitric oxide myoglobin in frozen meats containing nitrite and its fat antioxidant properties when combined with liquid smoke, suggested the possibility of new types of frozen cured meat products. The preparation of such products involves the application to the raw meat of brines or dry mixes containing curing salts, liquid smoke and ascorbic acid, followed by freezing. Experiments on the possible application of this freeze-curing process to the manufacture of presliced bacon are described in this paper. Bacon was selected because the brine could be applied easily by dipping the presliced raw pork, without the necessity of injections or arterial pumping.

EXPERIMENTAL

Materials. The pork used in all of the present experiments was obtained from a local slaughter house. The trimmed fat belly was thoroughly chilled overnight, then sliced to a thickness of 2 to 25 mm. The sliced bacon was dipped in the experimental brines for stated times, the individual slices wrapped immediately in polyethylene sealed with scotch tape and placed in a freezer at —17° C. (0° F.). For all of the variations for one experiment slices from the same fat belly were used.

Preparation of the dipping brines. The sodium chloride and sodium nitrite used in the brine preparations was of C. P. quality. Nitrite was not included in the curing salts because there is no opportunity for bacterial reduction of the nitrate in the freezer.

Unless otherwise stated, the ascorbic acid was in all cases adjusted to a pH of 6.0 before addition to the brine. This step is necessary because of the rapid decomposition of nitrite at pH values below 5. The pH adjustment was made either by addition of sodium hydroxide to ascorbic acid solutions, or by mixing sodium ascorbate and ascorbic acid.

The smoke flavor used was labeled "Imitation Hickory Smoke."[a] It was selected because it was previously found to have a desirable smoke flavor and a pronounced antioxidant effect both alone and also with ascorbic acid *(3)*. A 10% solution of this smoke was prepared by mixing one part of the concentrated commercial preparation with 5 parts of propylene glycol and 4 parts of water (all by weight). This solution was further diluted as necessary to give the final concentration stipulated in each brine.

The nitrite and ascorbic acid were added to the brines just before using. Brines were held at room temperature unless otherwise stated. The sliced pork was dipped in the brine for the time specified in each experiment, then drained for approximately 10 minutes. Individual slices were then wrapped in polyethylene and frozen immediately at —17° C.

Color ratings. The development and subsequent fading of the cured meat pigment was followed visually without removing the slices from their transparent wrappings. As standards for comparison, several slices in each experiment were treated with 1% potassium ferricyanide for 5 minutes, then rinsed, drained, and packaged for the freezer. This treatment brings about oxidation of the ferrous iron of the heme pigments to the ferric form, with a resultant change in color to a brownish shade. Slices so treated were used as negative controls and rated zero.

Slices of fresh, untreated pork were used as positive controls, rated ten. The original color faded only slightly during several months in the freezer. The pink color (oxymyoglobin) of these untreated slices of raw pork was slightly different from that of the nitric oxide myoglobin which developed in the brine dipped samples. However, the two pigments are sufficiently alike to make this a reasonably good standard.

Peroxide determinations were made on extracted fat from the stored bacon at approximate intervals as an objective measure of rancidity. The extracts were prepared by whirling 20 g. of bacon with 50 g. anhydrous sodium sulfate and 80 ml. of technical grade carbon tetrachloride for 2 minutes. After filtering, aliquots of the clear carbon tetrachloride solution of fat were dried to determine the amount of fat present and the fat peroxides estimated in aliquots of the extract containing about 0.5 g. fat *(6)*.

Palatability ratings. Samples of all lots of bacon were pan fried soon after reaching full color development in the freezer and compared with several brands of commercial bacon for saltiness, smoke flavor and general palatability. The comparisons were made by a small group of research workers. No attempt was made to set up numerical ratings.

RESULTS

Experiment I

Effect of ascorbic acid and smoke on rancidity and color development in brine-dipped pork. Preliminary experiments had established a concentration of brine ingredients sufficient to give

[a] Firmenich Inc., New York, N. Y.

a desirable salty taste and mild smoke odor after a 10-minute dipping period. The composition of the brine is shown in the first column of Table 1.

In order to evaluate the contribution of (a) the smoke and (b) the smoke plus ascorbic acid, to color development and rancidity control, two other brines were prepared, omitting the sodium ascorbate in one case and both ascorbate and liquid smoke in the other. Matched slices from the same green belly were dipped for a 10-minute period in each of the 3 brines, then drained and packaged. Some were stored in the refrigerator (4° C.), others in the freezer (−17° C.), with positive and negative color controls as previously described.

TABLE 1
Composition of dipping brines

Ingredient	Concentration in Brines (%)				
	Exps. I & II	Exp. III			Exp. IV
		No. 1	No. 2	No. 3	
Na Cl	5.0	10	10	10	8.0
$NaNO_2$	0.045	.09	.09	.03	.06
Ascorbate	0.22	0.5	0.1	0.1	0.5
Smoke	0.1	0.5	0.5	0.5	1.0

Figure 1 shows changes in color and rancidity over a 12 months' freezer storage period of slices dipped in (a) the curing salts alone and (b) the curing salts plus smoke and ascorbate. The color of all brine-dipped samples changed during the dipping period from the bright red of the original oxymyoglobin to a brownish shade only slightly better than the negative control. In the absence of ascorbate, no improvement of color took place during the 12 months in the freezer. In all samples containing ascorbate the typical pink nitric oxide myoglobin developed in 3 to 6 days in the freezer and this color had faded only slightly after a year. No color development took place in the refrigerator-stored samples over a 2-week period, at which time they were discarded because of bacterial spoilage. As shown in earlier work with hemoglobin solutions *(4)* and with ground pork *(5)*, the freezing is a necessary step in the formation of the nitric oxide myoglobin, probably because of the increase in effective concentration of all reactants (nitrite, ascorbate and myoglobin) by removal of water as ice.

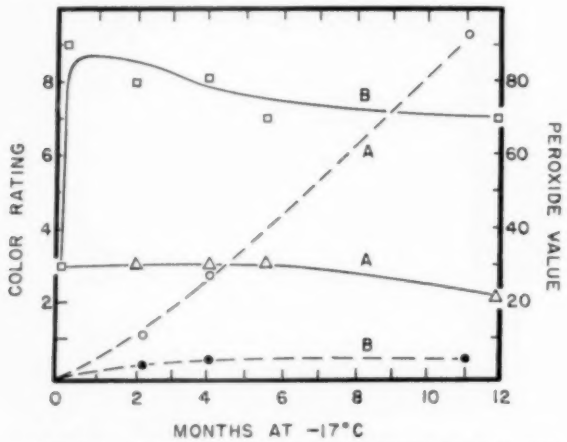


Figure 1. The effect of smoke and ascorbate on color and rancidity of dipped bacon held in the freezer.

Solid lines = color rating.
Broken lines = peroxide value.
A = control (dipping brine contained 5% NaCl and .03% NO_2).
B = Treated (dipping brine contained in addition to curing salts 0.22% ascorbate and 0.1% liquid smoke).

As shown in Figure 1, samples treated only with the curing salts became rancid very quickly. A rancid odor was apparent at 4 months. The combination of smoke and ascorbate prevented rancidity over the entire storage period. Smoke without ascorbate, not shown in the figure, also showed considerable protection (peroxide number 10 at the end of 11 months).

Experiment II

Effect of variations in dipping time, temperature and pH of the brine. Using the same brine composition, including the ascorbate and smoke, slices were dipped for 2, 5 and 10 minutes and stored in the freezer as previously described. Color development occurred in all of these samples at the same rate (complete in approximately 6 days) and all samples showed only slight fading after a year. However, in the 2 minute dip the smoke flavor was barely detectable. Peroxide values were not determined but the samples showed no organoleptic rancidity after a year.

A fresh lot of the same brine was divided into three portions and held at 5° C., 25° C. and 40° C. respectively during the dipping. The dipping time was 10 minutes. Those dipped at the two lower temperatures showed the same rate of color development and subsequent very slow color fading in the freezer. At the higher temperature, slight color fixation occurred during the dipping itself, but upon subsequent freezing the rate of color development was slower and the full pink color was never attained.

A third lot of the same brine was divided into three portions and their pH adjusted to 5.4, 6.0, and 6.7 respectively, using HCl and NaOH. The dipping time was 10 minutes. Slices dipped at pH 5.4 showed slightly accelerated color development in the freezer (full color reached in 3 days as compared to 5 days at pH 6.7). However, all samples looked alike at the end of 5 days in the freezer and no significant differences were noted in the degree of fading after one year of storage. None of the samples showed more than a trace of peroxide at this time.

Experiment III

Variations in brine composition and dipping time. Since Experiment II demonstrated that full color could be achieved and the fat protected from oxidative changes with dipping times of considerably less than 10 minutes, it was decided to increase the concentration of various brine constituents and cut down dipping time still more. The compositions of the 3 brines selected are given in Table 1. The sodium chloride and smoke concentration were increased over previous experiments but held constant in the three brines investigated here, whereas nitrite and ascorbate were varied.

In brine No. 1, containing the higher concentrations of nitrite and ascorbate, dipping times were varied (10 seconds, 1 minute, and 5 minutes). Only 1-minute dipping times were used with brines 2 and 3. The brines were held at 25° C. and the pH adjusted to 6.0. Samples were packaged and frozen as before.

Comparing samples dipped for different lengths of time in brine No. 1, it was found that slices dipped only 10 seconds were slightly slower in developing the red color during the first few days in the freezer, but at the end of 5 days they were indistinguishable from those dipped for a longer time; all had an excellent red color. Slices dipped for 5 minutes had a yellowish ting due to the absorption of excess smoke. The cooked bacon was judged to be quite salty at all dipping times. Smoke flavor was too mild at 10 seconds and too strong at 5 minutes. At the end of 9 months in the freezer, all samples had faded slightly. Peroxide numbers were negligible.

Slices dipped in brines 2 and 3, differing only in nitrite content, were not distinguishable from each other. However, all slices dipped in these brines, which had only one-fifth of the ascorbate concentration of brine 1, required much longer (approximately 10 days) to develop the red color in the freezer. The color, when finally attained, was equal to that of slices dipped in brine No. 1 and did not fade any more rapidly on prolonged storage. No more than a trace of peroxide was found in any sample after 12 months' storage.

Experiment IV

Effect of repeated dips in the same brine. In previous experiments only one batch of bacon was dipped in each brine solution and the solution was in each case freshly prepared. To make the process economically feasible, it would be necessary

to dip a number of lots of bacon in the same brine over a period of time. The compatability of sodium ascorbate and sodium nitrite in brines under various conditions has been investigated recently (*2*). This experiment was performed to compare color development in successive lots of bacon dipped in the same brine and to estimate the amount of brine necessary for processing a given weight of bacon.

Because brief dipping times in more concentrated brine solutions gave very satisfactory results in the previous experiment except for intensity of smoke flavor, concentration of the smoke was increased in this experiment, salt decreased, and dipping time set at 30 seconds. Composition of the brine is shown in the last column of Table 1. Since the smoke preparation employed becomes progressively less soluble in more concentrated salt solutions, this represents about the upper limit of smoke and salt which can be used. It is essential to withold the smoke until the salt has been dissolved in the full amount of water, in order to prevent flocculation of smoke constituents.

The total amount of brine used was 2 l. and the total weight of bacon was 10 lbs. Six slices of bacon, averaging slightly more than 0.5 lb. were placed on perforated plastic trays and dipped at one time. The first 12 lots were dipped in succession during the first hour after preparation of the brine. Additional lots were then dipped in the same brine after the brine had stood 2, 4, and 6 hours. The remaining brine was measured after all lots had been dipped.

With the idea that better distribution and penetration of the brine ingredients might be obtained if freezing were delayed, alternate lots of the bacon were (a) wrapped and frozen immediately, (b) wrapped and stored in the refrigerator for 1 to 2 hours before being transferred to the freezer.

Except for a slight lag in rate of color development in the samples dipped after 6 hours, all lots behaved alike. Color equal to the untreated control was attained in 7 days in all samples dipped within 4 hours after preparation of the brine. The same color was attained in 9 days in samples dipped after 6 hours. No difference was apparent in samples frozen immediately as compared to those held in the refrigerator before freezing.

The total amount of brine used for the 10 lbs. of bacon was 480 ml., or approximately 10% of the weight of the meat. At the quoted cost of $15 per lb. for the smoke concentrate and $7.50 per lb. for ascorbic acid, the total cost of the ingredients used per pound of bacon was approximately 2 cents. Assuming that all of the brine constituents were taken up by the meat in the same proportion in which they existed in the brine, the meat contained approximately 0.8% sodium chloride, .006% nitrite, .05% ascorbate and 0.1% smoke. The nitrite and ascorbate would be expected to decrease by reaction with each other and with the meat pigments.

DISCUSSION

The experiments described are all concerned with the dipping of pre-sliced raw pork, thus assuring surface application of the brine ingredients. However, the "freeze-curing" process is obviously not limited to this method of handling the meat. The brine ingredients can be incorporated directly in ground pork in the preparation of sausages, meat loaves, etc. The brine can be injected into intact green bellies or pumped into hams in the usual way and the meat subsequently frozen. Additional dry brine ingredients can be rubbed on the outside to increase the salt or smoke flavor and inhibit surface rancidity. Several rather crude injection experiments with fresh hams have been performed, but uniform distribution of the brine was not achieved, mainly because of lack of experience and suitable equipment for pumping operations. However, in the areas penetrated by the brine, typical cured meat color and flavor were present in the cooked product. There is no provision in the process, as described, for removal of excess water added with the brine in pumped or brine dipped meats.

The "cured" meat produced by this process differs from conventional cured meats in that the meat proteins are essentially undenatured, so that the meat looks like fresh untreated meat. The lack of denaturation is an advantage from a texture standpoint in frozen meats. Conventional heat cured products under the same storage conditions show much more evidence of surface dehydration (freezer burn) and separation of muscle fibers. The proteins of the "freeze-cured" product, like untreated raw meat, appear to be better able to remain in a fully hydrated condition. Upon subsequent cooking, the "freeze-cured" meat has the typical color, odor and flavor of the corresponding conventionally cured and smoked product, i.e. bacon or ham.

The freezing is an essential part of the process, necessay for the development of nitric oxide myoglobin. No information is available on the keeping qualities of the meat after removal from the freezer. The smoke preparation has some bactericidal effect (*1*), but the low salt and high moisture would probably preclude long storage periods outside of the freezer unless the meat were treated in some way to inhibit bacterial growth. The process as described would appear to be particularly adapted for use by operators of freezer lockers or for farm families. It is possible that a modified "freeze-curing" with sodium ascorbate might offer some advantages as a preliminary step with meat subsequently to be finished by more conventional smoke house or other heat treatments for distribution through regular commercial channels.

SUMMARY AND CONCLUSIONS

An excellent bacon-like product may be prepared by dipping the sliced raw pork into curing brines containing sodium chloride, sodium nitrite, sodium ascorbate and liquid smoke, followed by freezing. The undenatured cured meat pigment nitric oxide myoglobin develops within a few days in the freezer and shows little subsequent fading in storage periods of one to two years. The combination of ascorbate and smoke prevents rancidity indefinitely.

The composition, pH, and temperature of the brine and the dipping time may be varied widely with no obvious effect other than slight variations (3 to 10 days) in the time required for the cured meat pigment to develop in the freezer and differences in the degree of saltiness or smoke flavor in the bacon upon subsequent cooking.

LITERATURE CITED

1. Erdman, A. M., Watts, B. M., and Ellias, L. C. Smoke flavor and ascorbic acid as preservatives for fatty fish. *Food Technol.*, **8**, 320 (1954).
2. Hollenbeck, C. M., and Monahan, R. Compatibility of sodium ascorbate and sodium nitrite in meat curing mixtures. *Food Technol.*, **9** (12) (1955).
3. Watts, B. M., and Faulkner, M. Antioxidant effect of liquid smokes. *Food Technol.*, **8**, 158 (1954).
4. Watts, B. M., and Lehmann, B. T. The effect of ascorbic acid on the oxidation of hemoglobin and the formation of nitric oxide hemoglobin. *Food Research*, **17**, 100 (1952).
5. Watts, B. M., and Lehmann, B. T. Ascorbic acid and meat color. *Food Technol.*, **6**, 194 (1952).
6. Watts, B. M., and Peng, D. Rancidity development in raw vs. precooked frozen pork sausage. *J. Home Econ.*, **39**, 88 (1947).

Effect of Post Mortem Chilling on the Keeping Quality of Frozen Pork[a,b]

DOROTHY L. HARRISON, J. L. HALL, D. L. MACKINTOSH, AND GLADYS E. VAIL[c]
Departments of Foods and Nutrition, Chemistry, and Animal Husbandry, Kansas State College, Manhattan, Kansas

(Manuscript received August 26, 1955)

Palatability and chemical tests showed that pork from carcasses chilled 7 days before freezing deteriorated more during storage than carcasses chilled for 3 and 1 days. The temperature of chilling seemed to have little effect on the keeping quality of the pork.

It is generally believed that pork carcasses should be chilled and processed soon after slaughter. However, the rapid growth of the frozen food locker industry during the decade 1935-45 decentralized, to a certain degree, the slaughtering of hogs, and quick chilling was not always feasible. There was no standard pattern for the design of locker plants, and many were erected with a minimum of refrigeration for chilling carcasses.

The study reported herein was initiated to determine the effect of 2 temperatures and 3 periods of chilling pork carcasses on the keeping quality of frozen pork. The temperatures selected, 30° and 40° F. (−1.1° and 4.4° C.), represented practices common in the locker industry and the hanging periods, 7, 3, and 1 days, represented common practices as well as those considered desirable. Pork loin roasts from cascasses subjected to the various hanging periods at the 2 temperatures were tested at 8-week intervals from 0 to 48 weeks of frozen storage.

EXPERIMENTAL

History of the animals. Twice each year (February and June) for three years, 8 hogs, weighing approximately 250 pounds each, were slaughtered for an experiment. The hogs for 5 experiments were Poland China and Duroc breeds, raised by the department of animal husbandry. The hogs used in the sixth experiment were Hampshires raised on a farm near Manhattan, Kansas.

Chilling the carcasses. In all 6 experiments 4 lots of carcasses, 2 in each lot, were chilled in the following manner:

Lot 1. At 40° F. (4.4° C.) for 7 days.

Lot 2. At 30° F. (−1.1° C. for 1 day, followed by 32° to 34° F. (0° to 1.1° C.) for 6 days.

Lot 3. At 30° F. (−1.1° C.) for 1 day, followed by 32° to 34° F. (0° to 1.1° C.) for 2 days.

Lot 4. At 30° F. (−1.1° C.) for 1 day.

When the temperature of the chilling room was 40° F. (4.4° C.) the time required to reduce the internal temperature of the carcassas, measured in the ham, to 40° F. (4.4° C.) was 72 hours. At a chilling temperature of 30° F. (−1.1° C.) the internal temperature of the ham reached 36° to 38° F. (2.2° to 3.3° C.) within 24 hours.

Processing the loins. Slaughtering was scheduled so that all 8 carcasses for each experiment were cut and processed on the same day. The loins were removed with a fat covering of about one-half inch to provide adequate fat tissue for cooking and chemical tests. Each loin was divided into 4 roasts. The roast from the anterior end of the right loin was the fresh sample for the cooking and palatability tests, whereas the corresponding roast from the left loin was used for the chemical analyses and for assays of certain of the B-vitamins of the fresh pork. The *longissimus dorsi* muscle was used for testing the quality of the lean meat. Data concerned with the B-vitamins have been reported in a separate paper (*6*).

The roasts to be stored were wrapped in Cellophane, MSAT 87, with an outer wrap of waxed paper. They were frozen in a blast freezer at −10° F. (−23.3° C.) and stored at 0° F. (−17.8° C.) until analyzed. Roasts were withdrawn and tested for keeping quality at 8-week intervals up to and including 48 weeks of frozen storage. The storage periods were assigned to the roasts in sequence from the anterior to the posterior end of the loin, alternating between right and left loins. That is, the second anterior roast from the right loin was stored for 8 weeks, the corresponding roast from the left loin was stored for 16 weeks, and so on through 48 weeks of frozen storage. It was considered that with the large number of samples (336 roasts from 96 loins) any differences that may have existed from the anterior to the posterior end of the *longissimus dorsi* muscle would not be important.

Immediately after removing the roasts from frozen storage, the anterior end of each roast (approximately 2.5 inches) was used for chemical and B-vitamin analyses. The remaining portion was defrosted in a refrigerator at approximately 35° F. (1.7° C.) for 48 hours before cooking.

Cooking and sampling procedure. After each interval of storage there were two cooking periods. Four roasts, one representing each chilling treatment, were cooked at one time. The roasts were placed on a wire rack set in individual shallow pans, and roasted at 350° F. (176.7° C.) to an interval temperature of 185° F. (85° C.). Volatile, dripping, and total cooking losses were determined.

The *longissimus dorsi* muscle was separated from the ribs and vertebrae. The outside layer of fat over this muscle was placed in small jars and held in frozen storage until analyzed for peroxide oxygen and free fatty acids. A part of the inside fat, i.e., the fat directly covering the muscle was handled in the same manner. The remaining inside fat was reserved for palatability tests.

A core 1-inch in diameter was cut longitudinally through the *longissimus dorsi* muscle of each roast and sheared on the Warner-Bratzler shearing apparatus. Two 25-g. samples of ground muscle, including the core used for shearing, were pressed in the Carver laboratory press.

An experienced panel scored slices of the muscle for aroma, flavor, tenderness, and juiciness. Samples of inside fat also were presented to the panel to be scored for flavor. Scores for each factor were given within the range of 7 to 1.

Chemical tests. The following determinations were made on the raw *longissimus dorsi* muscle: pH, total nitrogen, and non-protein nitrogen. The total nitrogen and non-protein nitrogen in the press fluid also were determined.

The raw outside fat and both the cooked outside and inside fat were analyzed for peroxide oxygen and free fatty acids. Peroxide numbers were determined by the method of Lea (*3*) and acid numbers by titrating the free fatty acids in an aliquot

---

[a] Contribution No. 189 Department of Home Economics, No. 534 Department of Chemistry, and No. 207 Department of Animal Husbandry, Kansas, Agricultural Experiment Station, Manhattan, Kansas.

[b] Presented at the Fifteenth Annual Meeting of the IFT, Columbus, Ohio, June 15, 1955.

[c] Present address: Purdue University, Lafayette, Indiana.

of fat extract in neutral alcohol. The fat extracts were prepared as described by Watts and Peng (4).

Statistical analyses. Analyses of variance were run on the following data: total cooking losses; palatability scores for aroma, flavor of lean, flavor of fat, tenderness, and juiciness; press fluid yields from raw and cooked meat; shear values for cooked meat; pH of the raw meat; total nitrogen and non-protein nitrogen in raw muscle and in press fluid from raw meat; peroxide numbers for the cooked outside fat; and acid numbers for the raw and cooked outside fat, and the cooked inside fat. The analysis used was:

Sources of Variation	D/F
Treatments	3
Storage period	6
Experiments	5
Treatment × storage	18
Treatment × experiments	15
Storage × experiments	30
Carcasses, same treatment and experiment	24
Remainder	234
Total	335

The mean square for "carcasses, same treatment and experiment" was used as the error mean square in all analyses except when interactions occurred. If there were interactions, two-way tables of means were analyzed by least significant differences.

RESULTS AND DISCUSSION

Palatability Tests

Effect of chilling the carcasses. The average of mean palatability scores for roasts used in 6 experiments are presented in Table 1. The scores for aroma and flavor of fat were significantly ($P < .0$ and $P < .01$, respectively) affected by the temperature and time of chilling the carcasses. At individual storage periods there was little difference in average aroma scores for roasts from the 4 groups of carcasses. However, when the time of frozen storage was disregarded, the average aroma score for roasts from Lot 4 tended to be higher than the average aroma scores for roasts from carcasses given the other treatments. This explains the significant ($P < .05$) differences in aroma scores that were attributable to the time and temperature of chilling the carcasses.

Statistical analysis of the scores for flavor of the fat indicated that every method of handling the carcasses, i.e., the time and temperature of chilling, probably differed significantly from every other method of handling. An array of mean fat scores for each method of handling and calculation of least significant differences showed that fat from Lot 4 rated significantly ($P < .05$) higher than fat from Lot 3. Fat from Lot 1 had significantly ($P < .05$) better flavor than fat from Lot 2. The difference between mean flavor scores for fat from Lot 3 and Lot 1 approached significance at the 5% level. There were no significant differences attributable to the temperature and time of chilling the carcasses in the scores for flavor, tenderness, or juiciness of the lean meat.

Effect of frozen storage. The scores for all palatability factors, except tenderness, decreased significantly ($P < .001$) with frozen storage. Scores for aroma and for flavor of the lean pork generally decreased up to 40 weeks of storage.

When the method of handling the carcasses was disregarded, the mean flavor score for fat on the fresh roasts was significantly ($P < .05$) higher than that for fat on roasts stored for 8 weeks. The next significant ($P < .05$) decrease in these scores occurred between 16 and 24 weeks, and the final significant decrease between 32 and 40 weeks of frozen storage.

Between 24 and 40 weeks of storage the average juiciness scores were significantly lower than those for the fresh meat. The tenderness scores were not significantly affected by frozen storage.

OBJECTIVE TESTS

Average total cooking losses, press fluid yields from raw and cooked pork, and shear values for the cooked meat are given in Table 2. There were no differences attributable to the method of handling the carcasses in total cooking losses of the roasts, but differences in

TABLE 1

Average of mean palatability scores for pork loin roasts. (Highest possible score, 10)

Factor	Chilling treatment	Weeks in frozen storage						
		0	8	16	24	32	40	48
Aroma	7 days 40° F.	6.2	5.8	5.6	5.1	5.3	4.8	4.8
	7 days 30° F.	6.3	5.8	5.6	5.3	5.1	4.3	4.7
	3 days 30° F.	6.1	5.7	5.6	5.5	5.1	4.7	5.0
	1 day 30° F.	6.2	5.8	5.6	5.6	5.2	5.0	5.0
Flavor, lean	7 days 40° F.	6.4	5.7	5.7	5.2	5.4	4.9	4.7
	7 days 30° F.	6.4	5.8	5.4	5.4	4.8	4.4	4.7
	3 days 30° F.	6.2	5.8	5.7	5.4	5.0	4.9	4.9
	1 day 30° F.	6.3	5.7	5.7	5.4	5.2	4.7	4.8
Flavor, fat	7 days 40° F.	6.2	5.6	5.4	4.1	4.1	3.5	3.0
	7 days 30° F.	6.1	5.7	5.7	4.1	3.1	2.5	2.5
	3 days 30° F.	6.1	5.5	5.5	4.5	4.5	3.6	3.5
	1 day 30° F.	6.1	5.4	5.8	5.1	4.8	4.7	4.4
Tenderness	7 days 40° F.	6.2	5.9	5.8	5.6	5.7	5.9	5.9
	7 days 30° F.	6.3	5.9	5.7	5.7	5.7	5.8	5.8
	3 days 30° F.	6.1	5.8	5.8	5.5	5.6	5.8	5.8
	1 day 30° F.	6.0	5.8	5.5	5.4	5.6	5.6	5.8
Juiciness	7 days 40° F.	5.5	5.3	5.0	4.5	4.9	4.7	5.1
	7 days 30° F.	5.6	5.0	5.2	4.9	4.8	4.7	4.9
	3 days 30° F.	5.4	5.3	5.3	5.0	5.0	4.9	5.2
	1 day 30° F.	5.3	5.3	5.2	5.0	4.9	5.0	5.3

TABLE 2
Average total cooking losses, press fluid yields, and shear values for pork loin roasts

	Chilling treatment	Weeks in frozen storage						
		0	8	16	24	32	40	48
Total cooking losses, %	7 days 40° F.	34.1	33.8	32.5	32.9	32.9	35.2	32.3
	7 days 30° F.	33.5	34.5	30.3	29.9	30.8	33.3	33.7
	3 days 30° F.	35.2	33.5	30.7	31.6	31.2	34.8	35.3
	1 day 30° F.	35.0	34.0	32.1	30.6	34.6	34.2	34.0
Press fluid, raw pork, ml./25 g.	7 days 40° F.	7.4	7.8	8.1	8.4	8.0	8.0	7.8
	7 days 30° F.	8.5	8.9	8.3	8.4	8.2	7.9	7.2
	3 days 30° F.	8.7	8.9	8.4	8.5	8.2	8.3	8.3
	1 day 30° F.	9.2	9.2	8.9	9.2	8.7	8.5	8.9
Press fluid, cooked pork, ml./25 g.	7 days 40° F.	4.7	7.1	7.0	7.3	8.0	7.3	7.4
	7 days 30° F.	5.4	7.4	8.3	8.3	8.2	7.7	7.6
	3 days 30° F.	5.7	7.9	7.7	8.4	8.5	8.8	7.9
	1 day 30° F.	5.9	7.8	8.6	8.4	8.6	8.9	7.7
Shear value, lb.	7 days 40° F.	11.5	14.7	14.0	13.6	14.2	11.9	13.8
	7 days 30° F.	12.1	12.6	14.1	13.4	13.6	13.0	14.0
	3 days 30° F.	11.7	15.2	14.6	15.5	15.4	13.5	14.6
	1 day 30° F.	11.3	14.6	14.2	15.6	15.8	12.5	15.2

cooking losses among storage periods were significant. These differences may be associated with the cooking losses that occurred from 8 through 24 weeks of storage.

Press fluid yields. The method of handling the carcass significantly ($P < .01$) affected the volume of press fluid from 25-g. samples of raw *longissimus dorsi* muscle. The greatest yield of press fluid in the meat came from Lot 4. Statistical analysis also pointed out that there was a significant ($P < .05$) tendency for the methods of handling the carcass to compare differently from one experiment to another. For example, when the mean values for volume of press fluid for each experiment were calculated, the meat from Lot 1 yielded the lowest quantity of press fluid in the first, fourth, fifth, and sixth experiments, but gave the highest quantity in the second and third experiments. No explanation can be given for these differences among experiments. The volume of press fluid in the raw meat was not significantly affected by frozen storage.

Lot 1 yielded significantly ($P < .05$) lower volume of press fluid from 25-g. samples of cooked, ground meat from the *longissimus dorsi* muscle. No other significant differences in the volume of press fluid attributable to chilling were detected. The reduced volume of press fluid in Lot 1 was not reflected in total cooking losses or in juiciness scores.

When the data for press fluid yield for meat from all groups of carcasses were pooled, i.e., treatments were disregarded, there was a significant ($P < .05$) increase in the volume of press fluid after 8 weeks of frozen storage. The only significant ($P < .05$) change thereafter was a decrease in press fluid between 40 and 48 weeks. Juiciness scores were lower for frozen than for fresh pork. The relationship between greater press fluid and lower juiciness scores for frozen than for fresh pork was discussed by Hall *et al. (2)*. These authors indicated that as a result of freezing there may be a decrease in the water holding capacity of muscle tissue. They postulated that the rapid removal of meat juices by chewing, would soon leave a tasteless and apparently dry residue of tissue in the mouth. Therefore the palatability committee would score the meat low for juiciness.

Shear values. Like tenderness scores, shear values did not vary significantly with the time and temperature of chilling the carcasses or with frozen storage. Since storage periods were assigned to the roasts from the anterior to the posterior position in the loin, the non-significant differences among storage periods in both tenderness scores and shear values may indicate that there were no significant differences in tenderness from the anterior to the posterior end of the loin. This agrees with work reported by Bray, Vail, and Mackintosh *(1)*. Weir *(5)* compared several positions within pork loin among themselves, and found that the *longissimus dorsi* muscle was less tender in the center than at either end. However, when the total data were analyzed, variation in tenderness due to position within the loin was not statistically significant.

CHEMICAL TESTS

In Table 3 values are given for pH, total nitrogen, and non-protein nitrogen of the raw *longissimus dorsi* muscle, and for the total nitrogen and non-protein nitrogen in the press fluid from this muscle. The pH of the muscle from Lot 4 averaged significantly ($P < .05$) lower than the pH for meat chilled under the other conditions. The lower pH value of the muscle from Lot 4 probably indicates less enzymatic decomposition of lactic acid in this meat. Frozen storage significantly ($P < .05$) affected the pH of the raw *longissimus dorsi* muscle. When the methods of chilling were disregarded, an array of the mean pH values for each storage period and calculation of least significant differences indicated a significant ($P < .05$) increase in pH during the first 8 weeks of storage. Other significant ($P < .05$) changes in pH during storage were a decline between 16 and 24 weeks, then an increase between 32 and 40 weeks, which was followed by a decrease between 40 and 48 weeks.

Nitrogen content of muscle and press fluid. The differences in the percent of total nitrogen and non-protein nitrogen, expressed as percent of total nitrogen, found in raw *longissimus dorsi* muscle and in the press fluid from this muscle were not significantly affected by methods of handling the carcasses. Nevertheless, it is

TABLE 3
Average values for pH, total nitrogen, and non-protein nitrogen of raw Longissimus dorsi

Factor	Chilling treatment	Weeks in frozen storage						
		0	8	16	24	32	40	48
pH	7 days 40° F.	5.44	5.50	5.50	5.44	5.47	5.51	5.39
	7 days 30° F.	5.45	5.51	5.50	5.42	5.42	5.49	5.39
	3 days 30° F.	5.42	5.51	5.40	5.42	5.45	5.47	5.42
	1 day 30° F.	5.35	5.46	5.42	5.38	5.35	5.42	5.34
Total nitrogen, %	7 days 40° F.	3.39	3.46	3.43	3.58	3.59	3.59	3.57
	7 days 30° F.	3.32	3.45	3.38	3.55	3.56	3.56	3.51
	3 days 30° F.	3.34	3.47	3.41	3.53	3.57	3.57	3.57
	1 day 30° F.	3.30	3.45	3.37	3.51	3.53	3.51	3.53
Non-protein nitrogen, % total nitrogen	7 days 40° F.	12.5	12.5	12.5	12.6	12.6	12.6	12.4
	7 days 30° F.	12.8	12.7	12.8	12.8	12.8	12.5	12.5
	3 days 30° F.	13.0	12.9	12.6	12.9	12.6	12.4	12.3
	1 day 30° F.	12.9	12.6	12.8	12.8	12.6	12.6	12.6
Press fluid, total nitrogen mg./ml.	7 days 40° F.	16.5	17.6	17.6	17.6	18.4	17.7	17.6
	7 days 30° F.	16.5	17.8	17.6	17.4	18.1	17.5	17.4
	3 days 30° F.	18.3	19.0	18.8	18.9	19.4	19.1	19.0
	1 day 30° F.	17.7	18.3	18.4	18.7	18.8	18.8	18.4
Non-protein nitrogen, % total nitrogen	7 days 40° F.	32.3	30.6	30.6	30.8	30.4	32.2	31.8
	7 days 30° F.	31.3	30.4	31.1	31.1	30.8	31.7	31.2
	3 days 30° F.	28.5	27.6	28.4	28.4	27.8	28.9	28.7
	1 day 30° F.	29.4	28.5	29.0	28.4	28.0	29.4	29.8

interesting that the press fluid from meat of carcasses chilled for 7 days contained less total nitrogen than did meat of carcasses chilled for 3 or 1 days. However, a higher percent of the total nitrogen in the former samples was non-protein nitrogen. This relationship indicates more protein breakdown in the muscle from carcasses chilled for 7 days than in those chilled for 3 or 1 days.

Peroxide and acid numbers. Average peroxide and acid numbers for raw outside fat and cooked outside and inside fat are given in Table 4. In the majority of samples of raw outside fat and cooked inside fat no peroxide oxygen was detected and in all other of those samples the peroxide numbers were low; hence, these data were not analyzed statistically. The peroxide in the raw fat that appeared for 3 treatments at 16 weeks of storage and for 2 treatments at 32 weeks came from a single sample for each treatment, and probably should be considered insignificant. In fact, peroxide appeared in only 2 samples for each of the treatments showing peroxide at 40 and 48 weeks.

The fat on carcasses chilled for 7 days had higher peroxide and acid numbers than did fat of carcasses chilled for 3 and 1 days except for the peroxide numbers of cooked outside fat. The highest peroxide occurred in the fat of carcasses chilled at 40° F. (4.4° C.). In general, these results agree with the palatability scores for the flavor of fat.

TABLE 4
Average peroxide and free fatty acid numbers for raw and cooked fat

Factor	Chilling treatment	Weeks in frozen storage						
		0	8	16	24	32	40	48
Peroxide No.,[1] raw outside fat	7 days 40° F.	0	0	0.04	0	0.22	0.52	0.53
	7 days 30° F.	0	0	0.22	0	0.09	0.22	0.28
	3 days 30° F.	0	0	0	0	0	0	0
	1 day 30° F.	0	0	0.03	0	0	0	0
Peroxide No.,[1] cooked outside fat	7 days 40° F.	3.39	3.00	4.69	5.82	6.23	6.13	5.09
	7 days 30° F.	2.74	2.88	3.69	5.86	5.53	5.21	5.08
	3 days 30° F.	2.82	3.12	4.07	4.86	5.67	5.26	5.58
	1 day 30° F.	4.03	3.51	5.69	6.11	6.22	5.54	5.12
Peroxide No.,[1] cooked inside fat	7 days 40° F.	0	0	0	0.41	1.30	0	0.65
	7 days 30° F.	0	0	0	0.42	1.02	0.66	0.76
	3 days 30° F.	0	0	0	0.05	0.19	0	0.30
	1 day 30° F.	0	0	0	0	0.15	0	0
Acid No.,[2] raw outside fat	7 days 40° F.	0.57	0.55	0.49	0.77	0.70	0.79	0.87
	7 days 30° F.	0.50	0.67	0.60	0.90	0.74	0.88	0.90
	3 days 30° F.	0.38	0.39	0.38	0.50	0.52	0.51	0.62
	1 day 30° F.	0.30	0.36	0.31	0.46	0.48	0.48	0.59
Acid No.,[2] cooked outside fat	7 days 40° F.	0.54	0.74	0.79	0.73	0.87	0.85	0.88
	7 days 30° F.	0.64	0.92	0.88	0.94	0.89	0.84	0.95
	3 days 30° F.	0.42	0.56	0.56	0.60	0.60	0.56	0.64
	1 day 30° F.	0.44	0.46	0.48	0.55	0.58	0.55	0.61
Acid No.,[2] cooked inside fat	7 days 40° F.	0.47	0.53	0.63	0.55	0.52	0.65	0.68
	7 days 30° F.	0.55	0.64	0.54	0.71	0.66	0.71	0.82
	3 days 30° F.	0.33	0.37	0.44	0.49	0.45	0.51	0.59
	1 day 30° F.	0.37	0.38	0.41	0.43	0.41	0.44	0.58

[1] Ml. 0.002N thiosulfate per gram extracted fat.
[2] Mg. KOH per gram extracted fat.

The late development of peroxide in the inside cooked fat may be an indication of the rate of penetration of oxygen during chilling and storage. The higher diffusion rate at the longer chilling periods seems to account for the larger peroxide numbers for inside fat shown in Table 4.

Probably a more significant relationship between peroxide formation and the method of handling the carcasses is reflected in the number of samples having peroxide at any time during frozen storage. As shown in Table 5, the treatments with the 7-day chilling period

TABLE 5

Number of samples of fat having peroxide at any time during frozen storage

Treatment	Raw outside fat	Inside cooked fat
7 days 40° F.	6	12
7 days 30° F.	4	15
3 days 30° F.	0	6
1 day 30° F.	1	2

Total samples stored for each treatment—72.

produced all but one of the raw samples with peroxide and 77% of the cooked inside fat samples affected.

Analysis of variance of the peroxide numbers for the cooked outside fat showed that there were no significant differences in these values that were attributable to the method of handling the carcasses. The peroxide numbers of the cooked outside fat increased significantly ($P < .05$) between 8 and 16 weeks of frozen storage, and again between 12 and 24 weeks. Any further changes were non-significant.

Chilling the carcasses for 7 days produced significantly ($P < .05$) higher acid numbers for both raw and cooked outside fat than those developed by chilling the carcasses for 3 and 1 days. The time of chilling seemed to make less difference between the acid numbers for the two latter treatments. Nevertheless, in the outside raw and cooked fats the lowest acid number for each storage period occurred in samples from Lot 4 with one exception; i.e., the outside fat on the cooked fresh sample. The highest acid number for these same samples occurred in Lot 2 with two exceptions—the fresh raw fat and the outside cooked samples stored 40 weeks.

Acid numbers for raw outside fat increased significantly between 16 and 24 weeks of frozen storage, but there were no significant changes thereafter. Any differences in acid numbers of the cooked outside fat, which occurred during storage, were not important.

Acid numbers of cooked inside fat were not affected significantly by either the method of handling the carcasses or by frozen storage. However, there is a distinct break in acid numbers for inside cooked fat, between the long- and short-chilled samples, Table 4. Here again, the highest acid numbers at each storage period occurred in Lot 2, with one exception at 16 weeks. The lowest acid numbers occurred in Lot 4, with two exceptions—the fresh sample and that stored for 8 weeks.

VARIATION AMONG EXPERIMENTS AND CARCASSES

Differences are expected among experimental samples of biological material. Analyses of the data from the present study indicate that, in general, differences in the keeping quality of the pork, which existed among the 6 experiments are pronounced. Data varied significantly from one experiment to another for all factors used to judge the quality of the meat except aroma and tenderness scores, volume of press fluid and total nitrogen in the press fluid from the raw *longissimus dorsi* muscle, and the acid numbers of cooked inside fat.

There were wide differences among carcasses given the same treatment in the same experiment. Such differences were significant with respect to all factors studied except for scores assigned to aroma and flavor of lean meat and for the volume of press fluid in the cooked meat.

SUMMARY

The effect of 2 temperatures and 3 periods of chilling pork carcasses on the keeping quality of frozen pork was studied. The temperatures selected, 30° F. (−1.1° C.) and 40° F. (4.4° C.), represented practices common in the locker industry and the hanging periods 7, 3, and 1 days represented common practices as well as those considered desirable. Pork loin roasts were tested at 8-week intervals from 0 to 48 weeks of frozen storage.

Both palatability and chemical tests showed that pork from carcasses chilled for 7 days before freezing deteriorated to a greater extent during frozen storage than pork from carcasses chilled for 3 and 1 days. In general, there was little difference in the quality of the meat that was chilled for the latter two periods. The temperature of cooling seemed to have little effect on the keeping quality of the pork. Generally significant decreases in the quality of the meat occurred between 16 and 24 weeks of frozen storage.

Acknowledgments

The authors are indebted to Marjorie Barger and Armetta Watson for technical assistance.

LITERATURE CITED

1. Bray, R. W., Vail, Gladys E., and Mackintosh, D. L. Influence of freezing upon tenderness in aged beef. *J. Animal Sci.*, **1**, 81 (1942).
2. Hall, J. Lowe, Kalen, June, Westerman, Beulah D., Makintosh, D. L., and Vail, Gladys E. Keep the temperature low when storing pork. *Refrig. Eng.*, **24**, 696 (1949).
3. Lea, C. H. Effect of light on the oxidation of fats. *Proc. Roy. Soc.* (London) B. **108**, 175 (1931).
4. Watts, B. M., and Peng, D. Rancidity development in raw versus precooked frozen pork sausage. *J. Home Econ.*, **39**, 88 (1947).
5. Weir, C. Edith. The variation in tenderness in the *longissimus dorsi* muscle of pork. *Food Technol.*, **7**, 500 (1953).
6. Westerman, Beulah D., Oliver, Bess, and Mackintosh, D. L. Influence of chilling rate and frozen storage on B-complex vitamin content of pork. *J. Agr. Food Chem.*, **3**, 603-605 (1955).

Factors Influencing the Degree of Settling in Tomato Juice[a]

W. B. ROBINSON, LILLIAN B. KIMBALL, J. R. RANSFORD, J. C. MOYER, AND D. B. HAND

New York State Agricultural Experiment Station, Geneva, New York

(Manuscript received July 29, 1955)

Variations in processing conditions cause wide differences in the degree of settling of tomato juice. As a general rule juices with high gross viscosity exhibit a minimum degree of settling. The degree of settling is determined by the amount of insoluble solids in suspension. Rupture of the intact cells by homogenization reduces the degree of settling. The amount of pectin in tomato juice does not have a major effect on the degree of settling.

There are few data in the literature dealing with the factors that cause tomato juice to settle. When this defect occurs, the volume of suspended solids contracts leaving a pale yellow serum in the upper portion of the juice. Settling results in reduced customer appeal and is a recognized defect in the U. S. Department of Agriculture grades for quality.

During the course of studies on a pilot plant scale *(13)* conducted to determine the effect of processing conditions on the viscosity of tomato juice *(6)* wide variations were noted in the degree of settling in the samples of juice. The present paper relates processing variables to the practical problem of the settling of solids in tomato juice.

EXPERIMENTAL

Gross viscosity was measured at 30° C. by the Brookfield viscosimeter operated at 60 r.p.m. with spindle No. 2. Although this single reading gives only "apparent viscosity" in a non-Newtonian material such as tomato juice, the measurement serves the purpose of defining the relative thickness or body of the whole juice. *Serum viscosity* was measured at 30° C. with an Ostwald viscosity pipette after filtration of the juice.

Tomato juice was bottled in 12-ounce, tall-neck, glass bottles. Degree of *settling* was determined by measuring the distance from the top of the juice in the bottle to the top of the mass of suspended solids in the liquid.

Crude fiber was determined by the A.O.A.C. *(1)* method with the slight modification that 100 ml. of juice were used and made up to 200 ml. with 2.5 normal H_2SO_4 at a boiling temperature.

Pectin content, calculated as calcium pectate, was determined by the Poore modification *(14)* of the Carre-Haynes method. The following pectin fractions were prepared for precipitation of calcium pectate: (a) serum pectin, (b) water-soluble pectin on the suspended particles, (c) low methoxyl pectin on the particles, and (d) the protopectin on the particles.

The fractionation was conducted in the following manner: To determine the pectin content of the serum enough tomato juice was filtered through Whatman No. 1 filter paper to obtain 200 ml. of serum. Then 400 ml. of 95% alcohol were added to the serum with stirring and the mixture was then made 0.05 N with concentrated HCl.

To determine the water-soluble pectin content of the tomato particles, 200 ml. of the tomato juice were centrifuged at 2000 r.p.m. for 10 minutes. The supernatant was then filtered through Whatman No. 1 filter paper; the residues from centrifuging and filtration were combined and the filtrate discarded. The combined residue was extracted for 2 hours at 30° C. with 200 ml. of water, after which the mixture was centrifuged for 10 minutes at 2000 r.p.m. Extraction was repeated and the two extracts were combined after filtration through Whatman No. 1 filter paper.

In a similar manner the residue (after removal of the water-soluble pectin) was extracted twice with 0.5% ammonium oxalate for 2 hours at 30° C. to obtain the low methoxyl pectin and then extracted twice with 0.05 N HCl for 2 hours at 85° C. to dissolve the protopectin.

After fractionation, to 200 ml. of each extract were added 400 ml. of 95% ethyl alcohol and concentrated HCl added to bring the normality to 0.05. The mixtures were allowed to stand overnight and then filtered through sharkskin filter paper, washed 3 times with a 1 to 2 water-alcohol mixture, and twice with 95% alcohol. The filtrate was discarded and the residue was then washed through the sharkskin paper with hot water, the paper was washed 3 times, and the volume was made up to 200 ml. Then 150 ml. of 0.2 N NaOH were added, 25 ml. of 0.1 M. $CaCl_2$ were added dropwise with stirring, and finally 25 ml. of 2 M $CaCl_2$ were added slowly with stirring. The resulting mixture was brought to a boil, boiled for 2 minutes and filtered through sharkskin filter paper, after which the residue was washed 3 times with boiling water and then washed back into the beaker. The volume was made up to 100-200 ml. and again boiled for 2 minutes. The precipitate was then filtered through fritted glass crucibles of medium porosity (using very little suction) and washed 3 times with hot water, 3 times with 95% alcohol, and twice with ether. The samples were then dried overnight at 95-100° C. and the weight recorded as mg. of calcium pectate.

To determine the *particle size distribution* in the various tomato juices a 100 ml. sample was diluted to 3.5 l. with water. The sample was then put through a sieve-shaking apparatus[b] containing the following sieves arranged in order from top to bottom: 40, 80, 100, 140, 200, and 270 mesh. The sample was immediately followed by 3.5 l. of water. The shaker apparatus was stopped as soon as the last of the water had entered the apparatus. This took about 10 minutes. Occasionally the sieve became clogged and it was necessary to repeat the particle size separation with a new sample of juice. The sieves were then removed and the particles remaining on the sieves were transferred to 250 ml. graduate cylinders in the manner recommended by Kimball and Kertesz *(10)*. The volumes in the different fractions were recorded and the average particle sizes calculated. Because air bubbles adhered to the particles, it was necessary to allow the samples to stand in the graduated cylinders for 48 hours before the settling was completed. All samples were tested in duplicate and the averages were reported.

RESULTS

Viscosity. An inverse correlation was observed between the tendency to settle and the gross viscosity of the juice. Figure 1 shows this relationship for all of the experimental juice produced during the 1952 season. Although settling occurred principally in juice with a relatively low gross viscosity, this was only part of the story since even in juices of high gross viscosity the degree of settling varied from zero to more than an inch.

[a] Journal Paper No. 930, New York State Agricultural Experiment Station, Cornell University, Geneva, New York.

[b] Ro-Tap testing sieve shaker. Manufactured by W. S. Tyler Co., Cleveland, Ohio.

Since it is known that preheating temperature and finisher speed influence both serum and gross viscosity in tomato juice, it was decided to prepare experimental samples of juice in which serum and gross viscosity were allowed to vary independently. In order to obtain juice with as wide a variation as possible in both types of viscosity, two series of samples were produced. In the first series the preheating temperatures were varied from

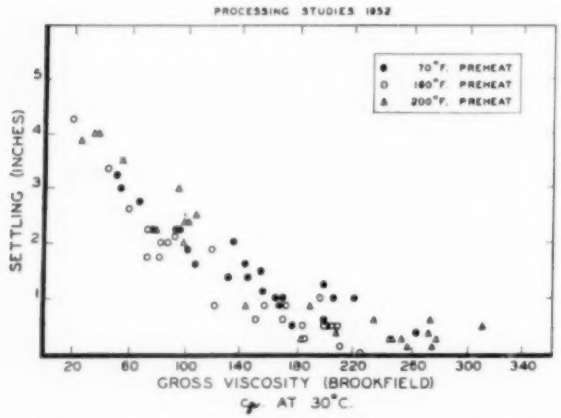


Figure 1. Gross viscosity vs. degree of settling in bottle.

70° to 200° F., and in the second series the speed of the finisher was increased from 200 to 1600. Table 1 gives the processing conditions, viscosity measurements, and degree of settling for these two experimental series. In the preheating series the degree of settling was at a minimum at the intermediate temperatures and the gross viscosity increased somewhat irregularly over the whole range of temperatures. Thus a simple correlation between gross viscosity and degree of settling did not hold true. In the finisher speed series the degree of settling decreased as the gross viscosity increased.

TABLE 1

Effect of preheating temperature and finisher speed on settling and viscosity in tomato juice.

Code no.	Preheating temperature	Finisher speed [1]	Degree of settling [2]	Gross viscosity [3]	Serum viscosity [4]	Ratio gross/serum viscosity
	° F.	*r.p.m.*	*inches*	*cp.*	*cp.*	
1	70	540	3.0	62	1.46	42
2	106	540	1.6	130	1.18	110
3	130	540	0.8	108	1.02	106
4	140	540	0.2	136	0.99	137
5	150	540	0.6	121	1.00	121
6	160	540	0.6	140	1.04	135
7	170	540	1.0	117	1.15	102
8	180	540	1.6	134	1.34	100
9	200	540	2.0	148	1.71	87
89	200	200	3.0	56	1.61	35
90	200	350	2.5	98	1.62	60
91	200	600	1.2	146	1.66	88
92	200	900	1.8	171	1.72	100
93	200	1250	0.4	209	1.84	114
94	200	1650	0	226	2.09	108

[1] F. H. Langsenkamp Co., Model 1858.
[2] Measured after standing 2 months in 12-oz. juice bottles.
[3] Measured at 30° C. with Brookfield viscosimeter using spindle No. 2 at 60 r.p.m.
[4] Measured in Ostwald pipette at 30° C.

It almost appears from a study of Table 1 that in the preheating series the degree of settling is directly related to the serum viscosity whereas in the finisher speed series the degree of settling is negatively correlated to the gross viscosity. A single function of viscosity that appears to be valid for both series is the ratio of gross viscosity to serum viscosity. Figure 2 shows a plot of degree of settling against this ratio.

Although from the data in Table 1 it might appear at first glance that high serum viscosity favors settling while high gross viscosity reduces the tendency to settle, the true explanation is probably simpler. Theoretically, viscosity of the serum should have nothing to do with the degree of settling although it would affect the rate. The data suggest, rather, that the degree of settling is determined by the constituent in the juice that makes a contribution to gross viscosity but not serum viscosity.

It is reasonable to assume that gross viscosity is a product of some function of "particle" viscosity and serum viscosity.[5] Under commercial conditions, measurements of gross viscosity should give a fairly accurate indication of the degree of settling to be expected. Processing conditions for minimum settling include an intermediate preheating temperature and, when a paddle type finisher is used, a high finisher speed. With a screw-type extractor adjusted to give a dry residue, juice with minimum settling is produced.

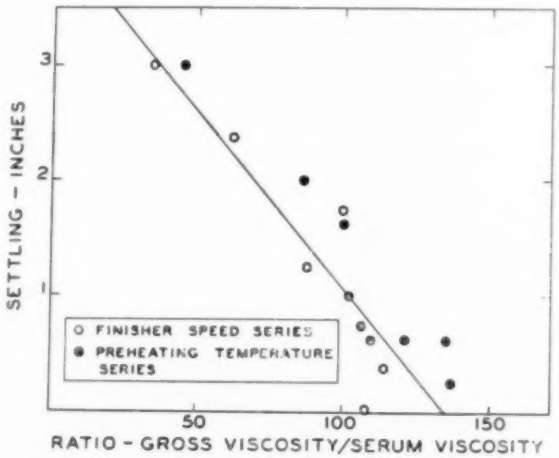


Figure 2. Relation between settling and viscosity ratio-gross/serum viscosity.

Crude fiber. The relation between viscosity and settling suggests that the tendency to settle may be determined by the suspended solids and may be relatively independent of pectin content of the juice. Crude fiber served as a measure of the amount af suspended solids. Analyses of crude fiber were made and the data reported in Table 2. In both series, settling is inversely related to the amount of crude fiber and becomes pronounced when the crude fiber falls to 0.20 or below. This means that the more solids that are suspended in the juice, the less will be the degree of settling. Since the available methods for all of the measured quantities are only semiquantitative, the data are not accurate enough to eliminate the possibility that some other factor besides crude fiber has at least a secondary influence on the degree of settling.

Pectin. Pectin, either on the suspended particles or in the serum, does not appear to have a direct effect on the degree of settling. In the preheating temperature series the total pectin passed through a minimum in the range of minimum settling.

[5] This assumption is based on analogy with colloidal solutions. Various workers *(2, 3, 7, 8, 9, 11, 12)* have related the viscosity of colloidal solutions to the viscosity of the solvent and the volume of the colloid in the solution. A theoretical equation *(4* and *5)* has also been derived which relates viscosity not only to the volume of the colloid in solution but also to the shape of the particle. Insofar as this assumption is correct, a measure of the contribution of the particles to gross viscosity can be obtained by dividing gross viscosity by serum viscosity.

TABLE 2

Crude fiber and pectin[1] content of tomato juices in relation to degree of settling

Code no.[2]	Degree of settling	Crude fiber	Pectin in serum	Pectin in suspended solids in mg. per 100 ml. juice			
				Water soluble	Ammonium oxalate	HCl soluble	Total
	inches	*%*	*mg. per 100 ml.*				
1	3.0	.15	68	17	66	7	90
2	1.6	.19	51	10	79	20	109
3	0.8	.21	14	4	34	0	38
4	0.2	.22	15	3	27	7	37
5	0.6	.23	25	4	35	2	41
6	0.6	.24	31	6	38	3	47
7	1.0	.20	73	9	41	3	53
8	1.6	.20	109	14	42	9	65
9	2.0	....	150	33	37	42	114
89	3.0	.12	118	13	18	10	41
92	1.8	.20	116	20	27	24	71
94	0	.23	133	20	68	32	120

[1] Determined as calcium pectate.
[2] Manufacturing conditions shown in Table 1.

But in the finisher speed series the pectin increased as the settling decreased.

Pectin is reported in Table 2 as calcium pectate. The pectin on the particles was determined in 3 fractions: water-soluble pectin, water-insoluble pectin after solution in ammonium oxalate, and water insoluble protopectin after solution in hydrochloric acid. None of the individual fractions was particularly interesting in relation to settling. In fact, the distribution of the pectin on the particles was such that all the individual fractions increased in proportion to the total amount of pectin, at least within the experimental error.

Data in Table 2 show that the amount of pectin in the serum ranged from 14 mg. to 150 mg. per 100 ml. The minimum amount of serum pectin occurred in the sample preheated to 130° F. and the maximum in the sample preheated to 200° F. The results show that a considerable amount of pectin is retained when the juice is processed without preheating. The distribution of pectin between the serum and particles depends upon the conditions of processing. At low preheating temperatures and low speeds there is more pectin on the particles than in the serum. At high preheating temperatures and at high speeds of the finisher the reverse is true. In general, however, when the serum pectin is high, the pectin associated with the suspended particles is also high.

Data in Tables 1 and 2 demonstrate that the serum viscosity is proportional to its pectin content. This relationship is shown in Figure 3. There is no reason to believe that any other constituent makes a significant contribution to serum viscosity.

Particle size. It was of interest to see if the degree of settling in tomato juice was related to the particle size, but no such relationship was found (Table 3). The apparent correlation in samples 89 to 94 was more likely caused by increasing amounts of suspended solids.

Weighted-average particle size increased with finisher speed (sample Nos. 89 to 94) but was less dependent on preheating temperatures (sample Nos. 1 to 9). The observed variation in weighted-average particle size did not appear to have an important effect on the degree of settling within the wide range of manufacturing conditions covered by Table 3.

It can be seen in Table 3 that the volume of particles passing the 200-mesh screen but retained on the finest screen (270 mesh) bore an inverse relationship to the degree of settling. This appears to indicate that fragmentation of the cellular material as well as the total amount may have an effect on the amount of settling. Homogenization will reduce the degree of settling and at the same time markedly reduce the average particle size. As a result of homogenization the effect of fragmentation on

TABLE 3

Particle size determination on tomato juices processed under varying conditions[1]

Code no.[2]	Degree of settling (inches)	40[4]	80	100	140	200	270	Total	Weighted ave. particle size[5]
		ml.	*ml.*	*ml.*	*ml.*	*ml.*	*ml.*	*ml.*	*microns*
1	3.0	5	68	28	33	16	8	159	230
2	1.6	8	74	32	41	38	18	211	217
3	.8	15	72	36	54	34	22	233	236
4	.2	10	66	41	42	41	21	220	219
5	.6	8	68	44	38	42	26	226	216
6	.6	9	64	42	38	43	26	222	217
7	1.0	8	75	44	31	35	16	209	229
8	1.6	19	98	51	32	28	12	240	258
9	2.0	14	81	41	29	26	6	197	250
89	3.0	3	51	44	39	28	8	173	211
90	2.4	4	67	30	56	27	12	196	218
91	1.2	12	72	47	37	30	7	204	238
92	1.7	11	87	58	34	34	10	234	236
93	.4	21	76	46	60	32	14	221	246
94	0	32	83	41	51	23	20	250	268
129[3]	0	1	6	4	13	56	73	153	116
143[3]	0	1	6	5	7	28	53	100	136

[1] See Table 1 for processing conditions.
[2] Manufacturing conditions shown in Table 1.
[3] Homogenized.
[4] Sieve openings in microns—420 177 149 105 74 53
Screen mesh no. — 40 80 100 140 200 270
[5] For method of calculation see (10).

the shape of the particles may be more important than average particle size in determining the degree of settling. This conclusion is confirmed by other observations that indicate that settling is a matter of the packing of the suspended particles into a smaller volume. For example, homogenization causes a marked increase in the volume of the particles after centrifuging. This appears to be associated with rupture of the cellular envelope. The ruptured cells do not settle as compactly as the intact cells *(6)*.

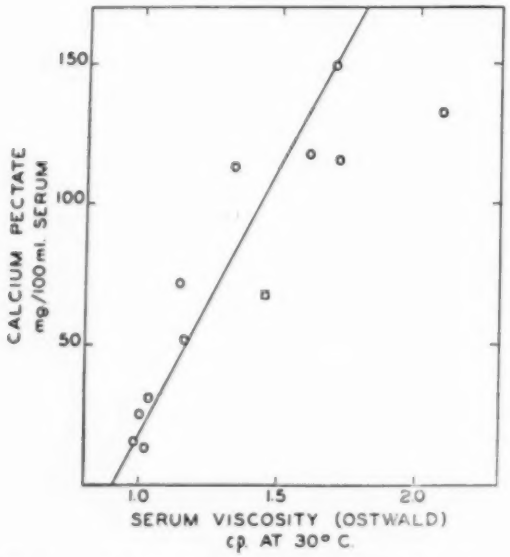


Figure 3. Relation betwen serum viscosity and pectin content expressed as calcium pectate.

DISCUSSION

In tomato juice the particles appear to be in contact and settling depends on packing of the particles. That settling is a matter of close packing of particles rather than a simple sedimentation is shown when the juice is diluted. After a 1:1 dilution with water the volume of the particles after settling is always greater than that in the original volume of juice. The packing of the particles is clearly evident when tomato juice is allowed to settle in tall-neck bottles. The shape of the bottle neck is frequently retained by the settling column of particles.

SUMMARY

As a general rule, there is an inverse relationship between the degree of settling and the gross viscosity of tomato juice. The degree of settling is determined by the amount of suspended solids and by the extent to which the intact cells are disrupted. The amount of pectin does not directly affect the degree of settling in tomato juice.

The phenomenon of settling in ordinary tomato juice is not a simple process of sedimentation but involves a closer packing together of particles in contact with each other.

LITERATURE CITED

1. Association of Official Agricultural Chemists. *Methods of Analysis*. 7th ed., 1950, p. 346.
2. Arrhenius, S. The viscosity of solutions. *Biochem. J.*, **11**, 112-133 (1917).
3. Einstein, A. A new determination of molecular dimensions. *Ann. Physik.*, **19**, 289-306 (1906); **34**, 591-592 (1911).
4. Eisenschitz, R. The viscosity of suspensions of elongated particles and their interpretation by space filling. *Z. physik. Chem., A158*, 78-90 (1931).
5. Eisenschitz, R. The influence of brownian movement on the viscosity of suspensions. *Z. physik. Chem., A163*, 133-141 (1933).
6. Hand, D. B., Moyer, J. C., Ransford, J. R., Hening, J. C., and Whittenberger, R. T. Effect of processing conditions on the viscosity of tomato juice. *Food Technol.*, **9**, 228-235 (1955).
7. Hatschek, E. The viscosity of dispersed systems. *Z. Chem. Ind. Kolloide*, **7**, 301-304 (1910).
8. Hatschek, E. The viscosity of dispersoids. *Z. Chem. Ind. Kolloide*, **8**, 34-39 (1911).
9. Hatschek, E. The existence and probable thickness of adsorption layers on suspended particles. *Z. Chem. Ind. Kolloide*, **11**, 280-284 (1912).
10. Kimball, L. B., and Kertesz, Z. I. Practical determination of size distribution of suspended particles in macerated tomato products. *Food Technol.*, **6**, 68-71 (1952).
11. Kunitz, M. An empirical formula for the relation between viscosity of solution and volume of solute. *J. Gen. Physiol.*, **9**, 715-725 (1925-1926).
12. Kunitz, M. Hydration of gelatin in solution. *J. Gen. Physiol.*, **10**, 811-836 (1926-1927).
13. Moyer, J. C., Holgate, K. C., LaBelle, R. L., and Hand, D. B. Tomato juice line. *Ind. Eng. Chem.*, **43**, 1874-1880 (1951).
14. Poore, H. D. Recovery of maringin and pectin from grapefruit residue. *Ind. Eng. Chem.*, **26**, 637 (1934).

Studies on English (Persian) Walnuts, Juglans regia. I. Evaluation of Skin Color in Shelled Walnuts[a]

LOUIS B. ROCKLAND, PATRICIA C. SLODOWSKI[b] AND ELIZABETH B. LUCHSINGER

Fruit and Vegetable Chemistry Laboratory, Western Utilization Research Branch, Agricultural Research Service, United States Department of Agriculture, Pasadena, California

A satisfactory procedure has been developed for the evaluation of walnut color based upon extraction with hot aqueous methanol and photometric estimation of the transmittance of the solution at 400 mμ. The color values expressed as 0 to 100 color units, were obtained by interpolation from a standard curve. Color evaluations on various commercial grades of shelled walnuts indicated wide variations in extractable skin color of different lots of the same grade of nuts. One half of a kernel of a dark walnut was sufficient to lower significantly the color value of a 25-g. sample of light-grade walnuts.

As part of an investigation on the preservation of shelled English walnuts, it appeared desirable to study the effects of heat, light, moisture, and oxygen on darkening of walnut-kernel skin. Darkening of walnut skins during storage appears to be associated with development of rancidity, although edible tree-ripe walnut meats may vary in color from light tan to brown-black (*15*). A visual comparison procedure is employed by the walnut industry for color grading of both in-shell and shelled walnuts as a basis for estimating their market value. However, the objective measurement of the skin color by direct colorimetric or photometric procedures is complicated by the convoluted surface and relatively large and irregular size of shelled walnut particles.

The solvent extraction technique, described in the present paper, permitted the elaboration of a satisfactory reproducible method for obtaining numerical values for skin color of walnut kernels and pieces as well as color changes associated with the development of staling and rancidity.

EXPERIMENTAL

Most of the walnuts employed in the present study were obtained from the 1952 and 1953 crops of a commercial budded variety (Placentia Perfection) grown in a single grove in Ventura County, California. All organic solvents were redistilled and free from any trace of color.

Preliminary studies. A number of pure organic solvents were tested to determine their efficacy for the extraction of walnut skin color. A 25-g. sample of a homogeneous lot of shelled walnuts was covered with 100 ml. of each solvent, respectively, and allowed to stand at room temperature for 24 hours. The effectiveness of each solvent for the extraction of colored pigments was judged by visual comparisons of the color of each extract in daylight. Since it was desirable to minimize extraction of walnut oil from the nutmeats, the solubility of cold-pressed walnut oil in various pure solvents was determined qualitatively. The results of both the extraction and the solubility studies are shown in Table I. It can be seen that methyl alcohol had optimum characteristics, extracting more color and less oil than any of the other solvents tested. In addition, the methyl alcohol extracts were sparklingly clear. Absorbance measurements at 440 mμ of three successive 24-hour extractions with each of 100% ethyl alcohol, 100% methyl alcohol, and 50% methyl alcohol indicated that one extraction removed 74%, 84%, and 65% of the total color that could be extracted by successive extractions with each solvent, respectively. The 100% methyl alcohol extracts contained approximately one-third as much, and the 50% methyl alcohol extracts four times greater total color in the 3 extracts than the 100% ethyl alcohol extracts.

TABLE 1

Solubility of walnut oil and walnut skin pigments in various organic solvents

Solvent	Walnut oil solubility[1,2]	Relative color extraction[3]
Carbon tetrachloride	M	0
Chloroform	M	0
Decalin	M	0
Benzene	M	0
tert.-Amyl alcohol	M	0
iso-Amyl alcohol	M	—
tert.-Butyl alcohol	M	
sec.-Butyl alcohol	M	
n-Butyl alcohol	M	1
Diethyl ether	M	1
Ethyl acetate	M	1
Benzyl alcohol	M	2
Allyl alcohol	M	
Propionic acid	M	
Isopropyl alcohol	PM	2
n-Propyl alcohol	PM	
Dioxane	M	3
Diethylene glycol monobutyl ether	M	
Ethylene glycol monobutyl ether	M	4
Diethylene glycol monomethyl ether	PM	4
Acetone	M	5
Ethyl alcohol	PM	5
Glycerine	PM	
Morpholine	PM	—
Methyl alcohol	I	10
Pyridine	M	15

[1] Fresh, cold-pressed walnut oil.

[2] M = Completely miscible in 1 to 10 volumes of solvent. PM = Miscible in some proportions. I = Immiscible.

[3] Estimated by visual comparison in daylight. Dash indicates that the solvent was not evaluated for color extraction.

Hot extraction at reflux temperature of 25 g. samples of walnut kernels with 100 ml. aliquots of aqueous methyl alcohol solutions containing 50 to 90% methyl alcohol resulted in slightly turbid solutions which could be clarified by filtration through hardened filter paper with the aid of Celite,[c] or by prolonged centrifugation. Centrifugation was not always effective in clarifying the extracts because of the presence, occasionally, of very small oil droplets. Hot aqueous solutions of methyl alcohol containing less than 50% alcohol produced a very turbid suspension which could not be clarified readily by either filtration or centrifugation. In general, color extraction decreased as the methyl alcohol concentration was increased from 50 to 90%. However, between 65 and 80% methyl alcohol, over 90% of the total extractable color was removed in the first of three successive extractions. The optimum concentration of methyl alcohol appeared to be 65 to 70% in terms of both the total extractable

[a] Presented at the Fourteenth Annual Meeting of IFT, Los Angeles, Calif., June 27-July 1, 1954.

[b] Present address: Princeton, New Jersey.

[c] Mention of special instruments or materials throughout this paper does not imply that they are endorsed or recommended by the Department of Agriculture over others of a similar nature not mentioned.

color and the efficacy of a single extraction. The relative effectiveness of various filter papers for clarifying walnut extract is indicated in Table 2. It may be seen from Tables 2 and 3 that at least two filtrations through slow, highly-retentive filter papers were necessary to clarify the walnut extracts.

TABLE 2

Effectiveness of various filter papers for the clarification of walnut extracts[1]

Filter paper	Relative clarity[2]	Filtration time[3]
		min.
Whatman No. 42	1	23
S & S No. 507	2	24
S & S No. 576	3	14
Whatman No. 44	4	14
Whatman No. 32	5	17
Whatman No. 50	6	17
S & S No. 589 BR	7	10
Whatman No. 40	8	1.5
Whatman No. 41	9	0.5

[1] A turbid 75% aqueous methyl alcohol extract of light-grade walnuts (25 g./200 ml.). Extracted 30 minutes at reflux temperature.

[2] Estimated by visual comparisons of filtrates illuminated with white light and observed at right angles to the light beam against a black background.

[3] Time required for filtration of a 15.0-ml. aliquot.

Transmittance spectra of walnut kernel extracts. The transmittance spectra of aqueous methyl alcohol extracts of light, medium, and dark colored walnut kernels, adjusted to equal volumes with solvent, were examined with a Coleman, Model 14, Universal Spectrophotometer. It may be seen in Figure 1 that the transmittance curves of the 50% aqueous methyl alcohol extracts of the three grades of walnuts were similar in character, with absorption minima at about 550 mμ. The transmittance spectra of these same extracts were identical when they were

TABLE 3

Clarification of walnut extracts by multiple filtration with hardened, fluted filter papers[1]

Filtration	1st	2nd & 3rd	4th & 5th
Filter paper	S & S 597	S & S 597, Whatman No. 42	S & S 597, Whatman No. 42
	Absorbance	*Absorbance*	*Absorbance*
Extract No. 1	0.103	0.068	0.069
Extract No. 2	0.164	0.133	0.124
Extract No. 3	0.297	0.229	0.227

[1] Extracts of 25.0 g. samples of light, medium, and dark walnut kernels with 65% aqueous methyl alcohol for 30 minutes at reflux temperature and made up to 200 ml. with 65% methyl alcohol. Measured with a Coleman, Model 14, Universal Spectrophotometer, at 400 mμ in calibrated 16.7 x 150 mm. borosilicate glass test tubes.

diluted appropriately to produce the same transmittance at 400 mμ and examined in the range 320 to 700 mμ using a Beckman, Model DU, Spectrophotometer. The walnut extracts were relatively stable under the usual laboratory conditions. The absorbance of aqueous methyl alcohol extracts increased about 5% in 24 hours and about 24% in 7 days when contained in stoppered flasks at 20 to 25° C. under normal laboratory conditions. However, no change in absorbance was observed within 3 to 4 hours under the same conditions.

Ferric chloride solution standards. The transmittance spectra of walnut extracts (Figure 1) are similar to those of both ferric chloride (3) and potassium dichromate (2). However, the ferric chloride solutions are easier to prepare and they have been shown to be stable for at least 5 years (3). The ferric chloride solutions described below served as convenient spectrophotometric standards for instrument calibration.

A saturated solution of ferric chloride in water was prepared at 25.6° C. A 75.1 ml. aliquot of the supernatant solution was removed through a fine sintered-glass filter and made up to 100.0 ml. at 20.0° C. with 6*N* hydrochloric acid. Three serial dilutions, 1:10, 1:100, and 1:1000 were prepared with 6*N* hydrochloric acid and referred to henceforth as the dark, medium, and light reference standards, respectively. Ten-ml. aliquots of each of the 3 solutions were pipetted into respective standardized

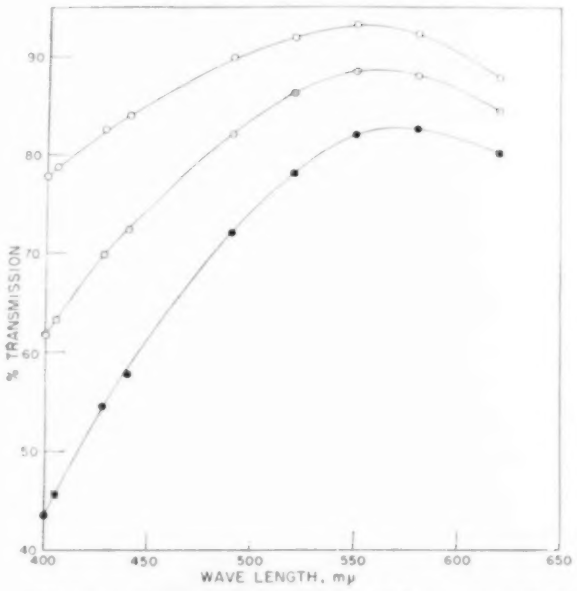


Figure 1. Transmittance spectra of 50% aqueous methyl alcohol extracts of three commercial grades of shelled walnuts. Light skin color—open circles; medium skin color—double circles; dark skin color—solid circles.

Coleman, Model 14, Universal Spectrophotometer, 16.7 x 150 mm. borosilicate glass test tubes.

19.2 x 150 mm. borosilicate glass test tubes (16.7 mm. I.D.) and quickly sealed at the top with an oxygen torch. The light and medium ferric chloride solutions encompassed the normal range of absorbance encountered with walnut extracts. The absorbance of the latter two ferric chloride solutions was nearly linearly related to concentration between 440 and 580 mμ but deviated significantly from linearity at 400 mμ, the wave length employed to determine the absorbance of walnut extracts. Therefore, the light and medium ferric chloride standards were arbitrarily assigned values of 61.6 and 330 color units, respectively, based on their absorbance at 400 mμ and the color unit chart shown in Figure 2.

Anomalous variation of the absorbance of the ferric chloride color standards compared with distilled water at 400 mμ, suggested that the absorbance of these solutions was temperature dependent. The absorbance of the three liquid standards and three walnut extracts was determined at 21.7°, 25.0°, 28.0°, and 33.9° C. and compared with a distilled water standard at 400 mμ. It may be seen from the examples presented in Table 4 that both

TABLE 4

Effect of temperature on the measurement of color in a ferric chloride solution and walnut kernel extracts[1]

Material	Temperature			
	21.7° C.	25.0° C.	28.0° C.	33.9° C.
FeCl$_3$ standard, 1:1000	56.8	61.6	65.2	73.6
Walnut extract A	48.8	50.0	50.4	51.2
Walnut extract B	97.6	100.0	100.8	100.8

[1] Expressed as walnut color units.

the walnut extracts, and especially the ferric chloride solutions, increased in color unit equivalents with increasing temperature. The absorbance of a piece of optically flat, polished amber glass,[4] used as a secondary reference standard, remained constant over

[4] Obtained through the courtesy of Dr. B. A. Brice, Eastern Utilization Research Branch, Agriculture Research Service, United States Department of Agriculture.

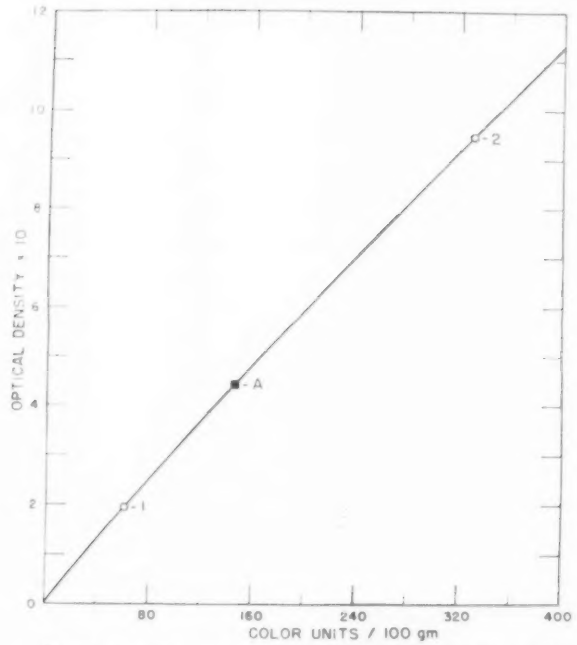


Figure 2. Color scale for shelled walnuts. 1—Light ferric chloride color standard. 2—Medium ferric chloride color standard. A—Amber glass color standard.

the same temperature range. Although the walnut extracts were not as markedly affected by temperature as the ferric chloride solutions, control of the solution temperature was considered necessary when the ambient temperature was more than 2° C. above or below 25.0° C.

Preparation of a color scale for shelled walnuts. Approximately 2 l. of aqueous (50%) methyl alcohol extracts of shelled walnuts were evaporated to dryness yielding a brown, glassy residue. A nearly saturated aqueous solution was prepared by dissolving 1.625 g. of the brown residue in 25.0 ml. of water, giving a solution containing 65.0 mg. of dried extract per ml. This stock solution was used in preparing a total of eleven 1:1 serial dilutions with 50% aqueous methyl alcohol. The 11 *ad hoc* walnut extracts contained from 0.0635 to 65.0 mg. per ml. of the dried walnut extract. Approximately 10 ml. of each solution was placed in each of three standardized 19 x 150 mm. test tubes and their absorbances compared with distilled water at 400 mμ and 25.0° C. A Ringbom curve (*1, 4*), in which percent absorptancy [100 (1-transmittance)] is plotted against the logarithm of the concentration, was prepared from the data. Analysis of the curve indicated that for a Relative Analysis Error (R.A.E.) of 5%, the range of concentration of dried walnut extract should be between 1.59 and 14.5 mg. per ml. corresponding to percent transmittances of 10 to 75%. For an R.A.E. equal to 10%, percent transmittances should lie between 4 and 86%, corresponding to from 0.75 to 22.7 mg. per ml. of dried walnut extract. The 5 artificial walnut extract solutions having percent transmittances falling within these ranges contained 1.015, 2.03, 4.06, 8.12 and 16.25 mg. per ml. of dried walnut extract, respectively. It was determined empirically that extracts prepared from shelled walnuts do not normally contain as much color as the solution containing 16.25 mg. per ml. of dried walnut extract. Therefore, the *ad hoc* walnut extract containing 16.25 mg. per ml. of dried walnut extract was arbitrarily assigned a color value of 400 units and the remaining four 1:1 serial dilutions were assigned color values of 200, 100, 50, and 25 color units, respectively. A plot of the absorbances of these five solutions against their assigned color unit values gave a curve which deviated slightly from a straight line as shown in Figure 2. However, based on the Ringbom curve analysis for an R.A.E. of 5%, the useful portion of the scale was shown to lie between 40 and 360 color units. For an R.A.E. of 10% the useful portion of the curve extended from 18 to 560 color units.

Extraction time. When reflux periods of 15 minutes or less were employed for extraction of the walnut kernels, extraction was incomplete and poor reproducibility was observed. Between 30 and 45 minutes, the color extraction was approximately 90% using a single extraction with 65% aqueous methyl alcohol at reflux temperature. A 30-minute extraction time was considered optimum since longer reflux periods did not increase either the color yield in a single extraction or the reproducibility of the determination.

Final color procedure. Approximately 25 g. of shelled walnut kernels, weighed to the nearest 100 mg., were placed in a 500 ml. round bottom, socket-joint flask and covered with 125 ml. of 65% (v/v) aqueous methyl alcohol. A ball joint condenser was attached and the mixture boiled for 30 minutes after being brought to reflux temperature in a boiling water bath. The flask was removed, stoppered, and cooled for 15 minutes in a cold water bath. The supernatant solution was decanted into a 200-ml. volumetric flask containing 1.0 ml. of a 50 mg. % solution of calcium chloride in 65% aqueous methyl alcohol. The calcium chloride aided clarification and stabilization of the walnut extracts. The residual extracted nuts were washed three times with a total of about 75 ml. of cold 65% aqueous methyl alcohol. The washings were combined with the supernatant solution and made up to volume at room temperature (25° C.). After thorough mixing, approximately 15 ml. of the methyl alcohol extract was filtered through a single layer of fluted Whatman No. 42 filter paper into a 19 x 150 mm. test tube. The filtrate was refiltered through a second fluted filter paper into a second standardized test tube, producing a sparklingly clear tan to brown solution. The absorbance of the walnut extract was determined with a Coleman Model 14 Universal Spectrophotometer at 400 mμ, standardized against the amber glass or ferric chloride solutions. By interpolation from the standard curve in Figure 2, the number of walnut color units in the extract was obtained.

The reproducibility of the procedure, based on a single hot extraction of 25.0-g. samples of shelled walnut kernels with 65% methyl alcohol for 30 minutes may be estimated from Table 5.

TABLE 5
Reproducibility of walnut color determinations[1]

Grade	Replicates	Range	Average	Standard deviation	$\frac{\sigma \times 100}{\text{Average}}$
	No.	*Color units*	*Color units*	σ	%
Light	6	19.2–23.6	22.0	1.56	7.1
Medium	6	36.0–47.2	38.7	4.35	11.2
Dark	6	71.6–81.6	75.6	3.97	5.3

[1] Expressed as color units/100 g. of walnut kernels.

The precision of the procedure was increased slightly by employing 50-g. samples of walnuts, probably because sample variations were minimized. However, the color yields, calculated as color units per 100 g., were about 1.5% lower than for 25-g. samples. The smaller, 25-g. sample was found to be satisfactory for routine applications.

The sensitivity of the method is reflected by the data in Table 6 showing the color ratings found for test mixtures of fresh,

TABLE 6
Estimation of color in ad hoc test mixtures of light and dark walnut kernels

Light kernels	Dark kernels	Color, found
%	%	*units/100 g.*
100	0	36.8
90	10	46.4
75	25	60.4
70	30	66.4
50	50	84.0
25	75	98.4
0	100	110.0

naturally light-, and dark-colored walnut meats. It may be seen that the presence of a dark, half walnut kernel, weighing approximately 2.5 g. or 10% of the total sample, increases the over-all color value by about 10 color units.

COLOR EVALUATIONS ON VARIOUS SAMPLES OF SHELLED WALNUTS

Color evaluations were made on three commercial grades of each of four varieties of shelled walnut halves and pieces. The results of these analyses are shown in Table 7. It may be seen that the different varieties of commercial grades of shelled walnuts varied in extractable color by as much as 100%. Even within a single variety (Eureka) the same grade of commercial walnuts varied over a relatively wide range.

TABLE 7

Color variations in samples of three commercial grades of four varieties of shelled walnuts [1]

Commercial grade	Variety				
	Franquette	Payne	Eureka		Placentia perfection (budded)
			Lot 1	Lot 2	
Light	20.8	16.0	20.0	34.4	40.0
Medium	36.8	38.8	52.4	68.0	49.2
Dark	64.0	66.0	82.0	120.0	110.4

[1] Expressed as color units/100 g. of shelled walnut halves and pieces.

It was shown in studies to be reported in a future publication that heating shelled walnuts for 120 hours at 60° C. will cause darkening about equal to that found during storage at 20° C. for 7 months. A uniform lot of light-colored shelled walnuts was adjusted to contain 3.04, 3.85, and 5.86% moisture and heated for periods up to 192 hours at 60° C. in sealed, air-tight glass jars. The relationship between the development of darkening and the moisture content of the walnut kernels is illustrated in Table 8. It may be seen that the color of the shelled walnuts increased markedly with both increase in moisture content and time of heating. Absorption spectra of the extracts of the original and the darkened walnut kernels were identical in character between 400 and 650 mμ, indicating that the darkening of walnuts is caused by an increase in the amounts of the same constituents that are present and measured in extracts of light-colored walnut kernels. The chemical nature of the tannins responsible for the color in walnut skins has not been elucidated. Preliminary chromatographic studies on the walnut extracts indicated the presence of a number of polyhydroxyphenols.

TABLE 8

Effect of moisture and accelerated storage on the color of shelled walnuts [1]

Accelerated storage time	Moisture content, %		
	3.04	3.85	5.86
hours	*color units*	*color units*	*color units*
0	20.4	22.0	22.8
48	28.4	32.4	79.2
192	44.0	65.2	83.6

[1] Light grade Placentia Perfection halves and pieces. Heated at 60° C. Color expressed as color units/100 g. walnut kernels. The small differences in color of the starting materials were due to changes during the adjustment of moisture content.

SUMMARY

A procedure has been developed for the estimation of skin color in shelled walnuts. The procedure consists of extraction of walnut kernels for 30 minutes with 65% aqueous methyl alcohol at reflux temperature, filtration of the extract, and photometric estimation at 400 mμ of the absorbance of the clarified solution. An arbitrary, numerical color scale has been devised to express the color values of shelled walnuts. Liquid color standards have been prepared and calibrated in terms of walnut color units. Data have been presented to indicate the reproducibility and sensitivity of the procedure. It has been shown that commercial grades of shelled walnuts vary markedly in color. The present procedure may be employed to estimate the rate of darkening of walnuts during storage.

Acknowledgments

This work was aided by the cooperation of and funds supplied by the California Walnut Growers Association. The authors are indebted to Donald M. Swarthout and Dr. J. C. Underwood for advice and technical assistance.

LITERATURE CITED

1. Ayres, G. H. Evaluation of accuracy in photometric analysis. *Anal. Chem.*, **21**, 652 (1949).
2. Kitson, R. E., and Mellon, M. G. Color of aqueous potassium dichromate solutions. *Ind. Eng. Chem., Anal. Ed.*, **16**, 42 (1944).
3. Mellon, M. G., and Kasline, C. T. Solutions for colorimetric standards. VI. Ferric chloride. *Ind. Eng. Chem., Anal. Ed.*, **7**, 187 (1935).
4. Ringbom, A. The accuracy of colorimetric determinations. II. *Z. Anal. Chem.*, **115**, 402 (1939).
5. Wright, R. C. Investigations on the storage of nuts. U. S. Department of Agriculture *Technical Bull. 770* (June 1941).

REGIONAL SECTION NEWS

(Continued from page 30 preceding technical papers)

Secretary: Richard L. Hall, McCormick & Company, Inc., Baltimore 2, Md.

Treasurer: Irving I. Cohen, Strasburger & Siegel, 1403 Eutaw Place, Baltimore 17, Md.

Councilors: Dr. H. Walter Kuhl, McCormick & Company, Inc., Baltimore 2, Md. (Elected) Mr. Leroy V. Strasburger, Strasburger & Siegel, 1403 Eutaw Place, Baltimore 17, Md.

Elected Member of the Executive Committee: Leonard F. Gieseker, National Can Corp., 1403 Eutaw Place, Baltimore 17, Md.

The Group, assembled for its annual social and Ladies Night, was addressed by Mr. Leroy V. Strasburger of Strasburger & Siegel, Consultants and Analysts to the Food Industry. His wide experience, both geographically and technologically, has made him a most valuable man in the Food Industry.

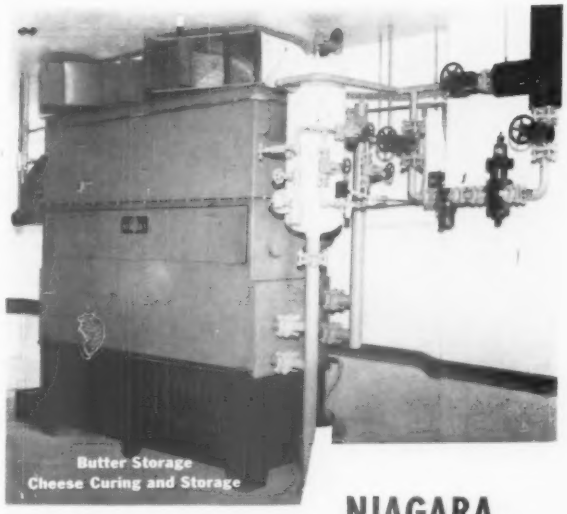
In conformity with these facts, he spoke on "The Adventures of an Itinerant Food Technologist." During Mr. Strasburger's experience he and his colleagues have worked on problems related to commercial canning, freezing, the production of dairy products, beverages, sea foods, bakery goods, confections, cereal products and many food specialties. While much of his work was connected with routine quality control and analysis, the most stimulating arose in the field of the solution of specific problems. Many solutions have come about by logical connection with somewhat similar former cases, while others were solved only after resorting to various analyses, microscopy, bacteriological differentiation, physical separation, or by actual duplication under controlled conditions.

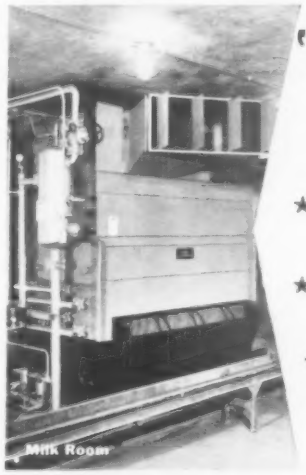
In the mid-1920's the prestige of a can manufacturer was saved when it was proved that peach discoloration was brought about by metallic tin combination with highly developed anthocyanins. These anthocyanins, water and alcohol soluble glucosides, are developed in dry seasons and in peaches show up as deep red colored areas. They are generally responsible for most of the blue, red and purple colors of nature. These areas showed up purple when canned in any manufacturer's cans. When cut out, no discoloration developed. The proof thus offered caused the accuser to retract publicly and apologize.

In 1928 a former Baltimorean decided, due to the abundance of Green Turtles in the area, to can them in the Windward Islands of the Bahamas. He sought Mr. Strasburger's firm's aid in this, and they developed a highly acceptable product which retailed for one dollar per No. 1 can. Of course the delicate flavor is partially improved by judicious addition of sherry wine.

In this same area at Nassau, Mr. Strasburger did some trouble-shooting in the processing of tomato juice for tomato paste. After observing the process, he found that a little more effort on the part of the fireman in maintaining proper steam pressure would provide vigorous agitation in the kettle's contents, thus preventing formation of an insulating blanket of sludge which prevented rapid and uniform evaporation of water and simultaneously caused a browning of the adhering mass. The near-perfect, individually-cared-for toma-

(Continued on page 38)





NIAGARA
"NO FROST"

25 Years Successful Experience

★ Protect frozen food quality

★ Get faster temperature "pull-down"

★ Never any defrosting shut down

Write for Niagara Bulletin 105

NIAGARA BLOWER COMPANY

Dept. F.T., 405 Lexington Ave. New York 17, N. Y.

District Engineers in Principal Cities of U. S. and Canada

DIRECTORY

The Institute of Food Technologists

President

LAVERNE E. CLIFCORN
American Can Company
Research Center
Barrington, Illinois

President-Elect

GEORGE F. GARNATZ
The Kroger Food Foundation
1212 State Avenue
Cincinnati 4, Ohio

Executive Secretary

CHARLES S. LAWRENCE
176 W. Adams Street
Chicago 3, Illinois

Assistant Executive Secretary

MARIAN A. GILCHRIST
176 W. Adams Street
Chicago 3, Illinois

Treasurer

AKSEL G. OLSEN
General Foods Corporation
1125 Hudson Street
Hoboken, New Jersey

Assistant Treasurer

ARTHUR N. PRATER
Gentry Division
Consolidated Foods Corp.
837 N. Spring Street
Los Angeles 12, California

Executive Committee of the Council

L. E. Clifcorn, P. K. Bates, G. F. Garnatz, A. G. Olsen, H. D. Brown, J. A. Dunn, A. A. Schaal, R. B. Wakefield, M. I. Wegner.

Councilors-at-Large

Terms Expire 1956: B. S. Clark, J. A. Dunn, C. N. Frey, L. A. Hall, H. S. Olcott.

Terms Expire 1957: G. M. Dack, S. L. Galvin, E. M. Mrak, C. S. Pederson, R. B. Wakefield.

REGIONAL SECTION CHAIRMEN, SECRETARIES AND COUNCILORS

CHICAGO, No. 1: Chairman, W. I. Mutschler. Secretary, Bernard J. McKernan, Continental Can Co., Res. & Dev., 4645 W. Grand Ave., Chicago 39, Ill. Councilors, G. E. Brissey, W. Conley, H. E. Goresline, H. H. Mottern, W. J. Mutschler, G. T. Peterson, C. K. Wiesman.

NORTHERN CALIFORNIA, No. 2: Chairman, B. Grossi. Secretary, Frank C. Lamb, National Canners Assn., 1950 Sixth St., Berkeley 2, Calif. Councilors, H. T. Griswold, E. E. Jacobs, J. H. Kilbucck, A. C. Richardson.

NORTHEAST, No. 3: Chairman, W. L. Cummings. Secretary, Ernest R. Barron, Fist National Stores, 5 Middlesex Ave., Somerville 45, Mass. Councilors, J. F. Caul, L. B. Sjostrom.

SOUTHERN CALIFORNIA, No. 4: Chairman, J. R. Lindquist. Secretary, Gordon L. Merchant, Merck & Company, Inc., 1855 Industrial St., Los Angeles 21, Calif. Councilors, W. E. Baier, M. E. Powell, M. S. Dunn.

ST. LOUIS, No. 5: Chairman, P. Logue. Secretary, Albert C. Roland, The Roland Flour Co., 3517 Gratiot St., St. Louis 3, Mo. Councilor, M. I. Wegner.

NEW YORK, No. 6: Chairman, R. C. Sherwood. Secretary, Ruth R. Bien, Good Housekeeping Bureau, 959 Eighth Ave., New York 19, N. Y. Councilors: F. C. Baselt, P. D. Kratz, F. K. Lawler, D. Melnick, A. A. Schaal.

FLORIDA, No. 7: Chairman, D. J. O'Brien. Secretary, Clarence W. DuBois, Minute Maid Corporation, Plymouth, Fla. Councilor, R. Patrick.

WESTERN NEW YORK, No. 8: Chairman, A. E. Guest. Secretary, Jean I. Simpson, College of Home Economics, Syracuse Univ., Syracuse 10, N. Y. Councilor, D. B. Hand.

GREAT LAKES, No. 9: Chairman, G. L. Alexander. Secretary, Robert B. Marshall, H. J. Heinz Co. of Canada Ltd., 25 Oak Street, E., Leamington, Ont., Canada. Councilors, J. Nelson, W. L. Scovill.

PHILADELPHIA, No. 10: Chairman, L. W. Mahle. Secretary, Norman Kramer, U. S. Food & Drug Adm., New Customhouse, Second & Chestnut St., Philadelphia 6, Pa. Councilor, J. P. Crimmins.

MARYLAND, No. 11: Chairman, W. J. Hart, Jr. Secretary, Richard L. Hall, McCormick & Company, Inc., Baltimore 2, Md. Councilors, H. W. Kuhl, L. V. Strasburger.

PUGET SOUND, No. 12: Chairman, G. M. Danielson. Secretary, Martha A. Poolton, Washington Co-Operative Farmers Ass'n, 201 Elliott Ave. W., Seattle 99, Wash. Councilor, C. W. Hurlbut.

AMES, No. 13: Chairman, R. T. Carey. Secretary, Frances Carlin, Foods & Nutrition Dept., Iowa State College, Ames, Iowa. Councilor, G. E. Cooper.

MOHAWK VALLEY, No. 14: Chairman, T. F. Irmiter. Secretary, Henry W. Ballou, Beech-Nut Packing Co., Canajoharie, N. Y. Councilor, M. Glickstein.

OHIO VALLEY, No. 15: Chairman, F. E. Deatherage. Secretary, Beatrice Finkelstein, 202 E. Bruce Ave., Dayton 5, Ohio. Councilor, H. D. Brown.

OREGON, No. 16: Chairman, E. W. Harvey. Secretary, Curtis J. Wilder, Food Technology Dept., Oregon State College, Corvallis, Ore. Councilor, C. L. Beardsley.

DIXIE, No. 17: Chairman, J. G. Woodroof. Secretary, Carroll F. Neff, 193 Princeton Way, N. E., Atlanta 7, Georgia. Councilor, J. O. Mundt.

TEXAS, No. 18: Chairman, J. H. Gast. Secretary, Kenneth K. Kenecaster, Converted Rice, Inc., P. O. Box 1752, Houston 1, Texas. Councilor, B. L. Golub.

AUSTRALIA NORTHERN No. 19: Chairman, V. M. Lewis. Secretary, Allan T. Roche, W. H. Brookhouse, Pty. Ltd., 92-100 Derby St., Auburn, N. S. W., Australia. Councilor, H. Govers.

INDIANA, No. 20: Chairman, S. E. Hartsell. Secretary, Verna McCallum, 941 N. Meridian, Indianapolis 6, Ind. Councilor, N. W. Desrosier.

PITTSBURGH, No. 21: Chairman, C. J. Steinicke. Secretary, John L. Secrist, H. J. Heinz Co., Food Research Dept., Pittsburgh 30, Pa. Councilor, H. L. Lang.

BRITISH COLUMBIA, No. 22: Chairman, D. H. Dougans. Secretary, William E. Pearson, Lucky Lager Brewing Co., 210 Brunette St., New Westminster, B. C., Canada. Councilor, I. F. Greenwood.

AUSTRALIA SOUTHERN, No. 23: Chairman, J. E. Rice. Secretary, Kevin B. Smith, Southern Can Co. Pty. Ltd., 240 Geelong Road, West Footscray, W-11, Victoria, Australia. Councilor, M. K. Paxton.

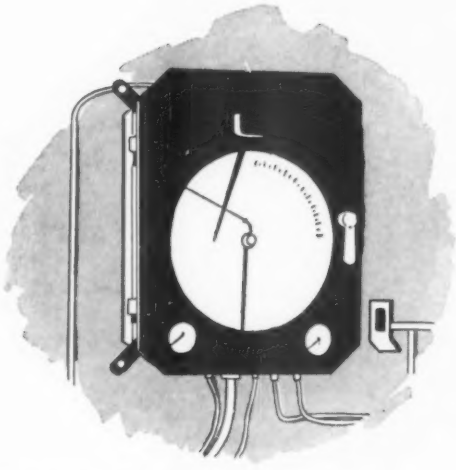
AK-SAR-BEN, No. 24: Chairman, G. C. Kolb, Jr. Secretary, Harriet L. Paige, C. A. Swanson & Sons, 1202 Douglas, Omaha 8, Nebr. Councilor, I. L. Ressler.

MEMBERSHIP

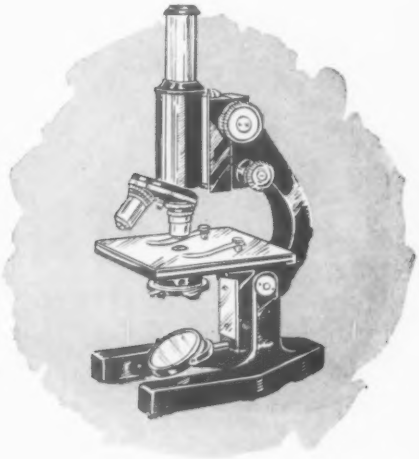
Write to nearest regional secretary, if within an area covered by a regional section, or to the Executive Secretary of the Institute for an application form and information regarding qualifications and classifications.

Need any help...

. . . in working out or changing an operation or product formula?



. . . in establishing correct processes?



. . . in identifying and controlling spoilage bacteria?

CANCO has concerned itself with the processing problems of canners for more than 50 years, and during that time it has been called upon to help solve just about every type of problem you can imagine.

Canco has a name for the particular technical services illustrated here... *Prompt Help in Food-Processing Problems.*

As Canco customers know, it is only one of many such services, all of which are made possible through the teamwork of canners and Canco's many specialists in all phases of the canning business.

Among the other services which Canco customers find helpful are:

1. **Advice on crop production problems**
2. **Advice on recipes and consumer preferences**
3. **Extensive delivery facilities to meet packing schedules**
4. **Advice on label information and design**

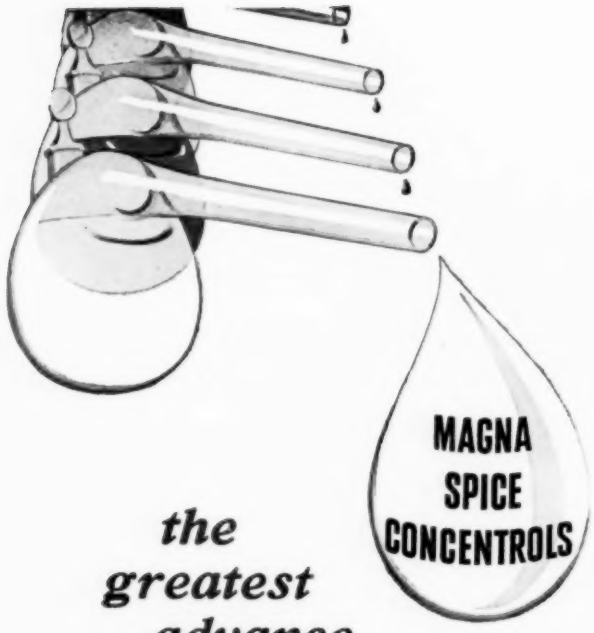
Canco offers more and better service than any other can manufacturer.

NATIONAL ENGINEERS' WEEK
Engineering... Builder of a Brighter Future

AMERICAN CAN COMPANY

New York • Chicago • San Francisco

COME TO CANCO FIRST!



the greatest advance in meat seasoning

Scientifically manufactured MAGNA SPICE CONCENTROLS have modernized the seasoning of meats by making available the true flavor components of herbs and spices in the most concentrated form known to Science . . . yet easily processed in your own plant. All the flavor is released immediately. Each batch of your product is uniformly and identically seasoned.

- **Out perform crude herbs and spices.**
- **Easy to measure — easy to mix.**
- **No spoilage.**
- **Cut seasoning costs up to 40%.**

Write for the new MM&R booklet — "The Greatest Advance in Meat Seasoning."

MAGNUS, MABEE & REYNARD, INC.

Since 1895 • **One of the World's Greatest Suppliers of Essential Oils and Flavors**

16 DESBROSSES STREET, NEW YORK 13, N. Y., U.S.A.
221 NORTH LaSALLE STREET, CHICAGO 1, ILL., U.S.A.

REGIONAL SECTION NEWS

(Continued from page 35)

toes, thereafter, were processed into a most suitable product.

At times Mr. Strasburger's advice has been spurned. In one such case a corn canner was made bankruupt when he processed corn in his brine tank which contained a copper coil. He was warned to remove the copper coil, but did not do so. The result—ten thousand cases of dirty blue-gray corn, unfit for market, worth thirty thousand dollars. The extensive loss also indicated complete lack of process quality control. Many changes in food are now known to be due directly to copper. Some are good but most are harmful.

Other difficulties the processor was fortunate in having remedied included:

Pitting of tin plate in canned cream style corn, caused by failure to vent air properly.

Glass particles in canned shrimp, caused by Struvite, a magnesium ammonium phosphate compound, occurring naturally.

Loss of green color in canned peas, prevented by a short high (260° F. for eight minutes) process in the presence of alkali so as not to exceed a pH of 8.0, as measured on the glass electrode.

Quality grading of canned food, standardized by the Canners League of California, which specified drained weights, number of units per can and syrup densities for peaches, apricots and pears. (Our Maryland firm was one of the first licensed score card graders of canned foods.)

Softening of tomatoes during processing; prevented by cancellation of sodium ion effect with calcium chloride as specified by Dr. Z. I. Kertesz of the Geneva Experiment Station. It was found that calcium causes precipitation of insoluble gels when they react with pectic acid.

Excessive firming of peas, caused by excessively hard (calcium) water.

Erroneous grading of oysters, caused by forced expulsion of liquor from oysters, using a colander. The liquor should be drained naturally and weighed not to exceed 15% of the total weight.

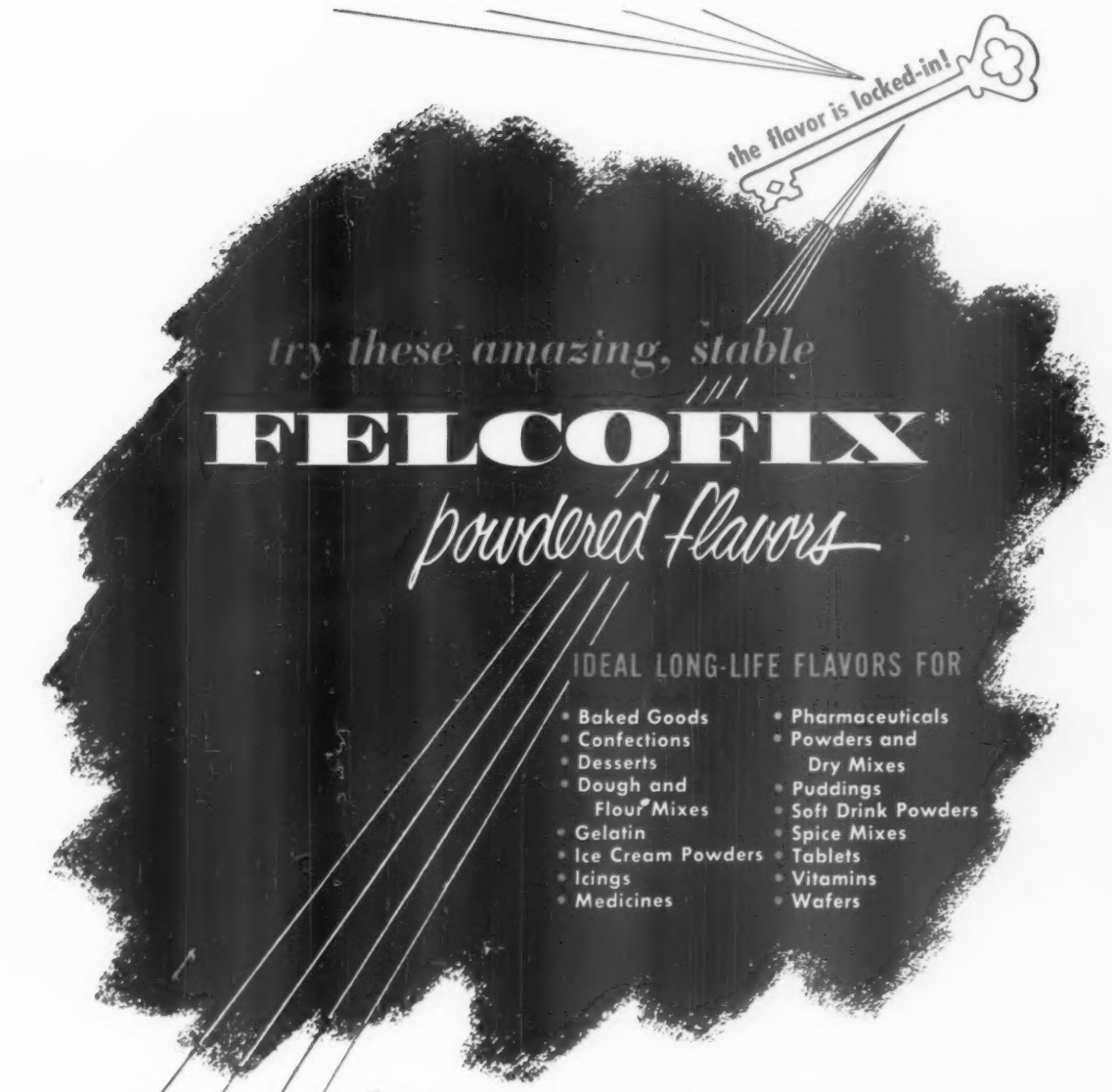
Discolored oysters, caused by chromogenic yeast due to unsanitary conditions or caused by algae in oyster beds; black color caused by iron in beds, green by copper, *e.g.*, French Marsenes oysters. (Copper in oysters is of nutritional importance in treatment of anemia.)

Canned hearts of cabbage palm, effected by careful control of a thermal process.

Since most of Mr. Strasburger's work has been with tomatoes, he then showed slides of tomato molds and elaborated on them. These included the molds *Alternaria, Fusarium Oospora, Mucor, Colletotrichum*, and even *Penicillium*. The last-named, although undesirable to the catsup maker, was picked up by the pharmaceutical houses and made to yield our first well-known antibiotic penicillin.

Mr. Strasburger then treated the Section to some expertly done and very beautiful slides on historic points of interest he "shot" during his itineraries.

(Continued on page 40)



try these amazing, stable

FELCOFIX*

powdered flavors

IDEAL LONG-LIFE FLAVORS FOR

- Baked Goods
- Confections
- Desserts
- Dough and Flour Mixes
- Gelatin
- Ice Cream Powders
- Icings
- Medicines
- Pharmaceuticals
- Powders and Dry Mixes
- Puddings
- Soft Drink Powders
- Spice Mixes
- Tablets
- Vitamins
- Wafers

Felton's complete line of FELCOFIX powdered flavors offers you the best answer to the problem of permanently flavoring all kinds of dry, semi-dry or powdered products . . . completely eliminating that old shelf-life bugaboo!

These outstanding flavors are supplied as dry, perfectly homogeneous powders that remain fresh, true and delicious even when used in mixtures containing acids, sugars and other reactive ingredients.

Their concentration and lasting power are equally amazing, and result in economies that are important to your profits.

It will pay you to try our* FELCOFIX *flavors without delay!

Write now for Samples of these amazing new FELCOFIX* locked-in FLAVORS

FLAVORS • ESSENTIAL OILS • AROMATICS

FELTON CHEMICAL COMPANY, INC.
599 Johnson Ave., Brooklyn 37, N. Y.

*FELCOFIX is a trade mark of Felton Chemical Co., Inc.

PLANTS: BROOKLYN, N. Y. • LOS ANGELES, CAL. • MONTREAL, QUE. • VERSAILLES (S & O) FRANCE
SALES OFFICES: ATLANTA • BOSTON • CHICAGO • CLEVELAND • PHILADELPHIA • ST. LOUIS • TORONTO

REGIONAL SECTION NEWS

(Continued from page 38)

NEW YORK SECTION

Chelating Agents Have Wide Food Application, New York Section Told. Properties and food applications of chelating agents were discussed in two informative talks at the November 16 meeting of the New York Section of the Institute of Food Technologists. Wide interest in this subject was evident from a near-record attendance exceeding 200 members and guests.

Chelating or sequestering compounds have become important food additives by virtue of their ability to form soluble complexes with troublesome dissolved metals. Thus, they prevent metallic ions from entering into their usual reactions.

The action of inorganic agents was described by Mr. C. G. Schneider of Calgon, Inc., Pittsburgh, while that of organic types was covered by Mr. H. W. Zussman, Geigy Chemical Corp., New York City.

Pointing out that polyphosphates are the only commercially important inorganic agents, Mr. Schneider cited their effectiveness in tying up calcium and magnesium ions in hard water. Another early application was in extracting pectin from apple pomace and citrus pulp. In this case, polyphosphates convert insoluble calcium pectinate to soluble sodium pectinate. About 2% of sodium metaphosphate increases the pectin yield by 20% or more, he said.

Polyphosphates also tenderize the skins of pectinous vegetables during blanching. In process cheese and ice cream they act as a stabilizer. More recently, they have been used in the processing of various cured meats to improve cured color, color stability, and moisture retention.

Turning to organic chelating agents, as exemplified by ethylene diamine tetraacetic acid (EDTA), Mr. Zussman detailed their use as solubilizers or precipitation inhibitors. Important in these applications is the fact that organic chelating materials can be made oil-soluble.

Also cited were other functions such as the clarification of wine, controlling of wildness in beer, and the prevention of discoloration in pre-peeled potatoes.

On the matter of toxicity, there is ample evidence that EDTA may be safely used at levels below 100 p.p.m., the speaker said. However, there is some question of tolerance when they are introduced into a diet marginal in minerals.

The subject of chelating agents is one of a series of talks constituting the Section's theme for this year—Functional Uses of Food Additives—introduced at the October 19 meeting with a timely review by Dr. Bernard Oser, Food Research Laboratories, Long Island City, N. Y.

Subsequent talks will deal with:

1. Preserving Food by Irradiation.
2. Sweetening Agents.
3. Use of Nutritive Food Additives.
4. Antioxidants, Synergists, and Oxygen Acceptors.
5. Colors in Processed Foods.

PHILADELPHIA SECTION

The Annual Ladies' Night Dinner meeting was well attended at the Drexel Institute on December 13, 1955.

All those attending were presented with gifts of candy, perfume (for men and women) and various items of foods donated by the Section member companies. Dr. E. F. Kohman, Food Consultant, briefly related his experiences as a consultant for a large Italian food manufacturer.

Mrs. Corinne Robinson, Professor of Home Economics, Drexel Institute of Technology, presented a paper on the topic: "Food Facts and Fallacies." The topic and facts presented were especially appropriate and well appreciated by the numerous lady guests. She stressed the importance of educating the consumer to buy and eat intelligently; to partially overcome the increasing trend in foolish fads and fallacies that exist in this country. Mrs. Robinson stated that such fads were costing the consumer about $500,000,000 a year and all going into the pockets of "quacks." These "quacks," she pointed out, were at times so successful because they appeal usually to one's emotions; they relate half truths and invariably exaggerate the known facts. In addition, they are usually super salesmen and in most cases have something to sell for which they realize great profits. To protect the public from these quacks she emphasized the need of publicizing authoritative information, more honest advertising and the scientists' responsibility to make the facts known to all the people.

PERSONNEL

Dr. H. Hurwicz, formerly with the Trane Company, La Crosse, Wisconsin, has been appointed Senior Scientist with the Advanced Development Division of AVCO, Stratford, Connecticut. This division is devoted exclusively to research and experimental activities in numerous fields of science. Dr. Hurwicz will be doing fundamental research in the fields of heat transfer and thermodynamics, both analytical and experimental.

In Memoriam

Words cannot express our sorrow in informing you of the death of Joseph W. Holmquist, a member of the Chicago Section and a Charter Member of the Institute of Food Technologists. "Quist" passed away on December 17th, following a prolonged illness. He was 50 years old.

Bill Holmquist was a well-known figure in the food canning industry, having been associated with it for the past 25 years. His amiable disposition and affable manner will be sorely missed. News of his death brings sadness to a host of personal friends in IFT and in the canning industry.

Services were held December 20th at the Kampp Funeral Home, Wheaton, Illinois.

—from the *Newsletter*, Chicago Section.

for fruit and vegetable growers... NEW HELP ON BACTERIAL BLIGHT

Recent greenhouse studies by scientists at Merck & Co. Inc., show that addition of Glycerine to streptomycin sprays increases the effect of the antibiotic against bacterial blight of beans, a disease which costs farmers millions of dollars each year.

Researchers believe the increased effectiveness of the combined spray comes from Glycerine's ability to retain moisture on leaves, and in so doing, to improve absorption of streptomycin by the plant.

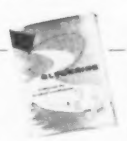
Indications are that the Glycerine-streptomycin combination will also help control other disease-causing organisms which infect leaves, flowers and stems of various fruits and vegetables.

This is only one of Glycerine's many applications in agriculture and industry. The unique balance of properties that has won such wide acceptance for Glycerine in the past continues to open new doors to chemical progress. In paints, foods, pharmaceuticals, packaging . . . for tomorrow's surge of new specialties . . . in formulations and reactions yet unknown, nothing takes the place of Glycerine.

This balanced group of properties keeps Glycerine's usefulness growing

HYGROSCOPICITY • STABILITY • HUMECTANT •
SOLVENT POWER • VISCOSITY • NONVOLATILITY • CARRIER • SOLVENT • LUBRICANT • SOFTENER •
NONTOXICITY • TASTE • MW/HYDROXYL RATIO • EMOLLIENT • ANTI-FREEZE • ALKYD BASE •

☑ CHECK AND SEND FOR TECHNICAL DATA



☐ 20-page booklet on Glycerine for product conditioning

☐ 8-page booklet on "Federal Specifications for Glycerine"

☐ 16-page booklet on Glycerine properties and applications

For your free copy of any or all of these booklets write: GLYCERINE PRODUCERS' ASSOCIATION • 295 Madison Ave., New York 17, N.Y.

✔ Designed
✔ Tested
✔ Proved

Fries & Fries Flavors

Fine Flavor Formulations for the Food Industry

Our flavor research laboratories are at your service

ASK FOR SAMPLES

Three generations of experience

MANUFACTURING CHEMISTS
FRIES & FRIES INC
CINCINNATI U.S.A.

NEW YORK..... 418 East 91st St.
SAcramento 2-2260

CINCINNATI..... 110 East 70th St.
VAlley 1-7200

Books

HAWLEY'S TECHNICAL SPELLER. Compiled by Gessner G. Hawley and Alice W. Hawley. Reinhold Publishing Corp. New York, N. Y.

Hawley's Technical Speller is designed as a desk book for the technical man or woman who as editor, proofreader, author, or teacher needs to know the spelling of troublesome words. Terms from chemistry, engineering, metallurgy, electronics, medicine and physics are represented in the list of over 8000 words selected.

The compilers have evidently maintained a checklist of the culprit words in the vocabulary of modern science and in addition have noted down many common words that are trouble-makers. For example, it is pointed out that if you are referring to mathematical reference points, the spelling is "indices" but if you mean the lists of subject matter topics or authors used in books or periodicals the spelling is "indexes." It is little distinctions like this that can escape one for years.

Major emphasis in this convenient little book is on scientific words, and between "abaca" and "zymurgy" the editors have not only given the correct spellings of thousands of difficult words but have also furnished their syllabic divisions, brief distinctions between the meanings of words closely similar in spelling ("homogenous" and "homogeneous," for instance), and answers to those irritating little problems "Should this be spelled as one word or two? Is this word hyphenated? Should I capitalize?"

As the compilers point out, no book of this type can meet all needs. The attempt to achieve such a goal must be reserved for the unabridged dictionary. But within the confines of a handy desk book such as this one there are perhaps a few further services that might in a future edition be rendered the technical worker; namely, accent marks to indicate the pronunciation of some of the scientific jawbreakers included, an increase in the number of bacteriological and microbiological terms represented, and possibly a section on the abbreviations commonly used in the natural sciences.

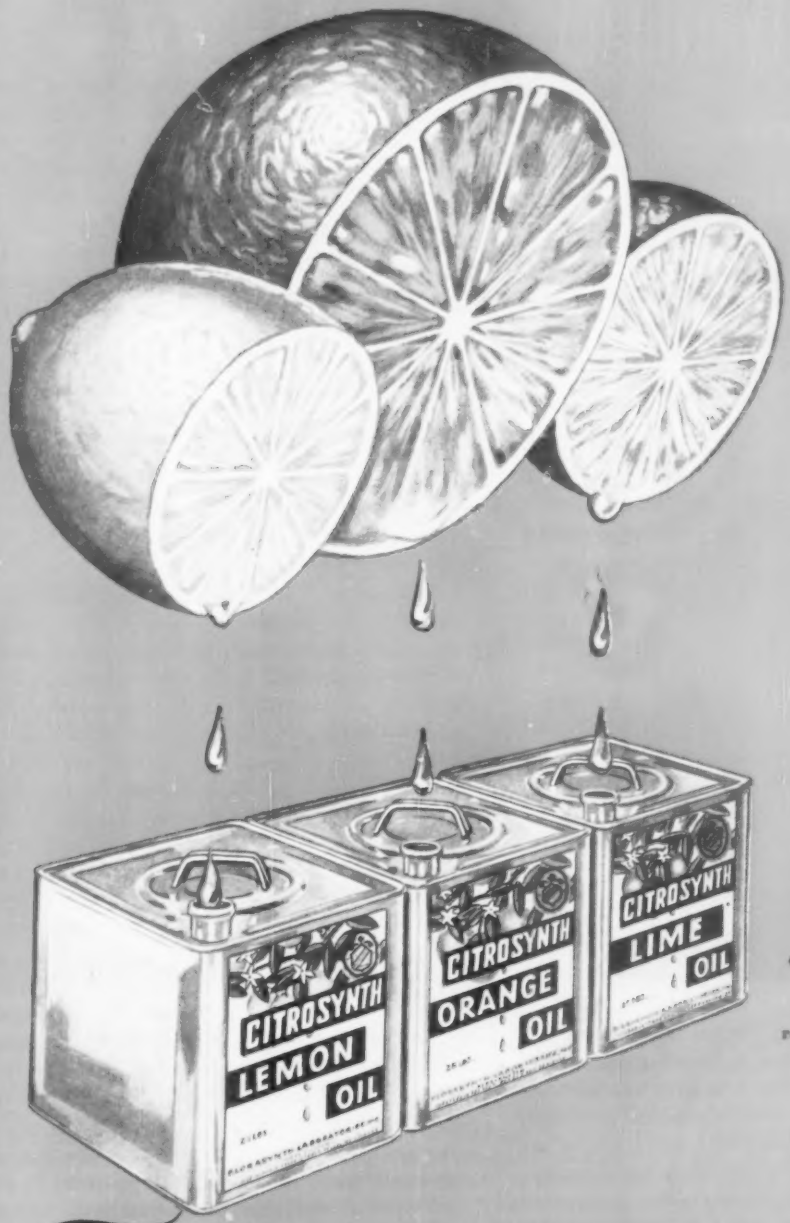
MARTIN S. PETERSON
Chicago, Illinois.

HEFE UND ALKOHOL SOWIE ANDERE GÄRUNGSPRODUKTE.* Hermann Kretzschmar. Springer-Verlag Berlin, Göttingen, Heidelberg, 1955. 648 pp., 176 illustrations.

In Germany for at least 25 years no comprehensive work has appeared summarizing the information contained in the vast number of technical publications dealing with yeast and alcohol production. This fact is pointed out by the author in his prefatory comment, and it was with the idea of filling this gap that he prepared

* As the title will indicate, the book is in German.

(Continued on page 44)



Created by Nature . . . Duplicated by Florasynth

. . . Retaining the inherent goodness and richness of the natural product, these superb compounds of natural oils are evidence of Florasynth's matchless skill of research and distillation.

Florasynth LABORATORIES INC.

Executive Offices: 900 Van Nest Ave., (Box 12) New York 62
Chicago 6 • Los Angeles 21

CINCINNATI 2 • DETROIT • DALLAS • MEMPHIS • NEW ORLEANS 12
ST. LOUIS 2 • SAN FRANCISCO • SAN BERNARDINO
FLORASYNTH LABS (Canada LTD.) • MONTREAL • TORONTO • VANCOUVER • WINNIPEG
Agents and Distributors in Mexico, COMSOLMEX S. A. MEXICO 11, D. F.

BOOKS

(Continued from page 42)

the present book. Although most emphasis is given to yeast and alcohol, the author has also included various other microbiological processes, such as the citric acid-, acetic acid-, lactic acid fermentation, the production of antibiotics, drugs, food yeast, vitamins and enzymes. Wine, beer and cheese fermentations were excluded, the author explains, since they did not constitute part of the subject matter under consideration.

Scope and contents. The 24 chapters are clearly subdivided and deal with the following topics: History of yeast production, raw materials (substrates), theories of fermentation (a rather weak chapter), the production of yeast and alcohol, sulfite waste liquor fermentation, saccharification of wood, special bacterial and mold fermentations (organic acids, alcohols, antibiotics, vitamins, enzymes, dextran, fat, etc.). Other chapters deal with special procedures to improve the quality of bakers yeast, manufacture of active dried bakers yeast, food and feed yeast, and other special preparations. The last part of the book covers distillation procedures, uses of alcohol, yields of yeast and alcohol, control instruments, analytical procedures, importance of water supply, and waste disposal. Forty-one general references, mostly to other books, are listed at the end of the volume. There are numerous diagrammatic sketches of equipment, flow diagrams, and a number of photographs (176 illustrations). In the reviewer's opinion, the greatest value and strength of the book lie in the considerable practical experience that the author draws upon in most of the fermentations covered.

Limitations. In spite of its many valuable attributes, the book has a number of weaknesses. The field, together with the related areas which the author has tried to cover, is so extensive that it is difficult to imagine how a single person could ever hope to cover all this material thoroughly and adequately. Editors of similar handbooks have been aware of this problem and have, as a rule, relied on the participation of a number of experts to encompass the task. As one result of the single authorship, perhaps, the literature has been reviewed rather superficially. Few up-to-date references to original articles are included and many names are quoted which do not appear in the short bibliographies which conclude the chapters. To the reviewer, a part of the value of such a handbook would be its bibliographic resources—the availability of important citations to original recent literature. Such a feature is virtually lacking. Similarly, few references are given in the chapter dealing with analytical procedures, although at the end of the book the Official Federal Methods are listed for the analysis of brandy and spirits. Since many persons are quoted without being listed in the references, it would appear that the author has based a good deal of his material on personal communications with colleagues.

Another point which bothered the reviewer somewhat was the inclusion in certain chapters of a good deal of old information of only doubtful historical significance. Illustrative of this is the section on vitamins and that on the theory of alcoholic fermentation.

Audience. In spite of certain weaknesses, the handbook, "Yeast and Alcohol" should be useful to persons wishing to orient themselves in one or more aspects of the field of industrial microbiology, particularly with respect to the technology of yeast and alcohol production—which are the topics covered most extensively. This applies to students, technologists, engineers, laboratory technicians, and research scientists in allied fields.

Format. The make-up of the book is good. The table of contents is extensively subdivided and an adequate subject index can be found in the back. Probably because few references are quoted, an author index is lacking.

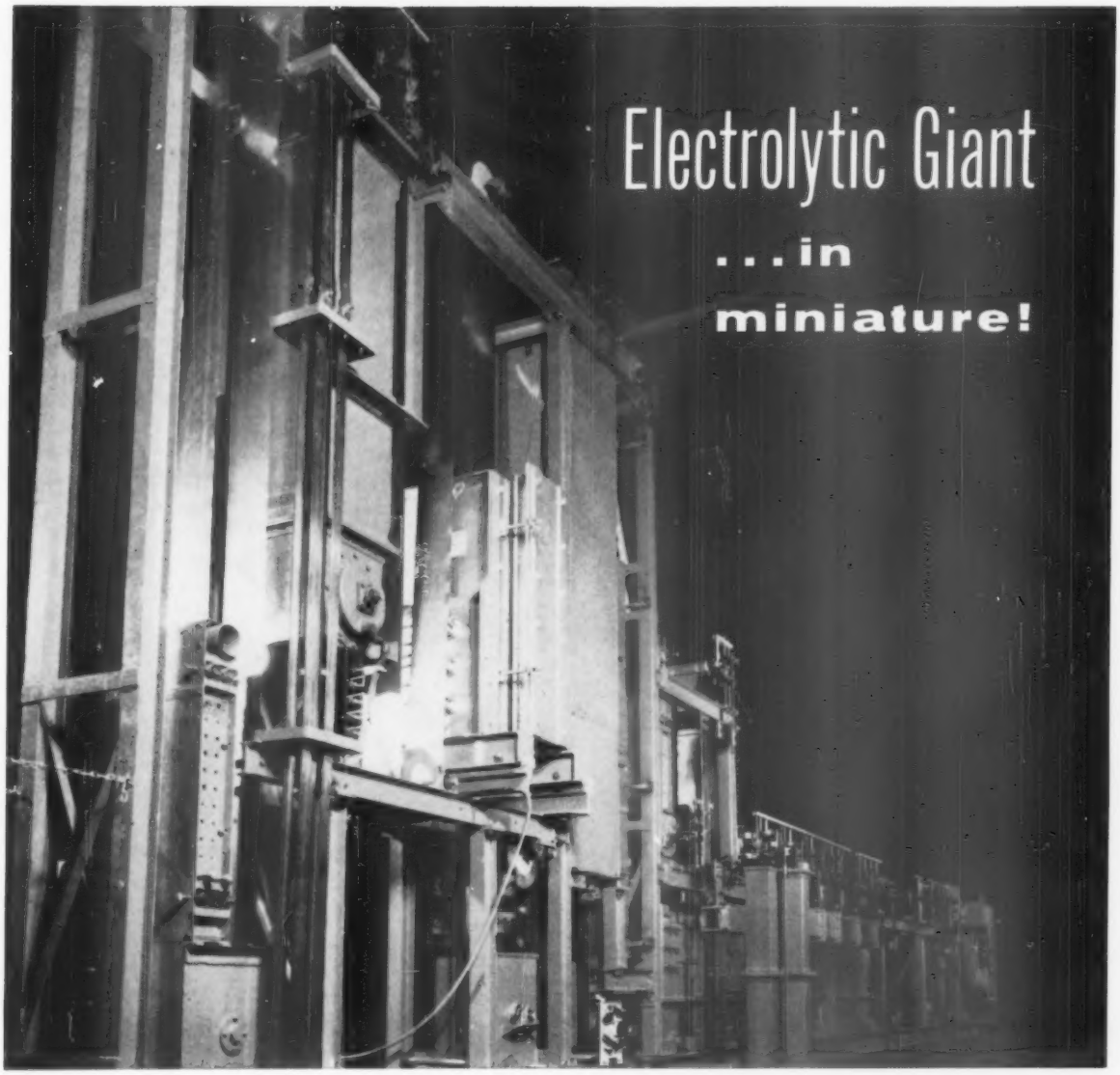
HERMAN J. PHAFF
Davis, California

INSTRUMENTS FOR MEASUREMENT AND CONTROL. Werner G. Holzbock. Reinhold Publishing Corporation, New York, N. Y., 371 pages.

As stated by the author, the objective of this book is three-fold: to acquaint the reader with the types of instruments available for the measurement and control of process variables; to be a reference book for those who are searching for an instrument that fills their specific needs; to give the man who develops new instruments an opportunity to compare some of the approaches used by his colleagues in the solution of problems common to the instrument industry. In carrying out this objective, the author has described the operational characteristics, as well as in many instances, the structural details of typical instruments. The fifteen chapters of this book are devoted to: temperature; humidity and moisture; pressure; flow; liquid level; density; viscosity; speed; analysis; automatic controller action; electric controllers; self-operated, pneumatic, and hydraulic controllers; time function controllers, final control elements; and, trends.

Each chapter is replete with schematic diagrams showing construction and methods of operation of the instruments under discussion. These diagrammatic presentations provide a useful supplement to discussion and types of application as covered in the text. As suggested by the various chapter headings, every section of this book contains discussions of instrumentation which have application in the broad fields of food technology and food process engineering. Although many of the instruments described and their applications will undoubtedly be familiar to most food technologists, this book provides a valuable source of reference covering the broad field of instrumentation. It should serve to provide ideas for the development of automatic control systems in the food processing plant.

(Continued on page 46)



This isn't the gigantic mill that it appears to be. Instead, it's a junior edition of a full-sized electrolytic tinning line. It measures a mere 100-feet long as compared to the 340-foot length of its big brothers in actual production.

Despite its comparatively small size, the job assigned to this miniature mill is a big one. Located in the new United States Steel Applied Research Laboratories, Monroeville, Pa., this pilot line transforms roll upon roll of 6-inch steel strip into shining tinplate at the rate of 800 feet per minute.

The tinplate produced on this pilot line is used for research studies in United States Steel's continuing research campaign to improve the protective qualities of tinplate and to make even better cans for foods and the variety of products packaged in cans. These objectives are so important that more than ten thousand tests are made on tinplate each week in the Applied Research Laboratory.

By working in close cooperation with the tin container and food packing industries, United States Steel Research Engineers have been able to contribute substantially to the production of finer, more protective tinplate products, which, in turn add to the ever-expanding variety of canned goods to be found in the marketplaces of the world. It illustrates how United States Steel is constantly working to give America finer and more efficient products made of steel.

USS TINPLATE

USS

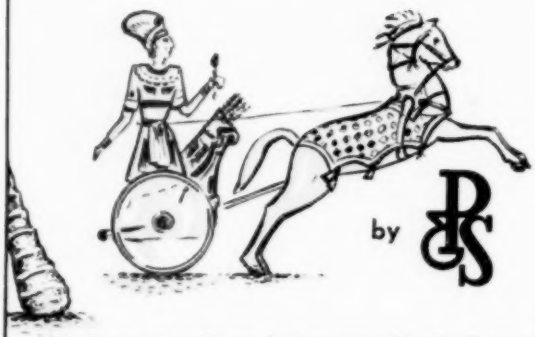
UNITED STATES STEEL CORPORATION
525 William Penn Place, Pittsburgh 30, Pa.

UNITED STATES STEEL

from the
WORLD OF YESTERDAY

to the
MANUFACTURING
PLANTS OF TODAY

Pyramid
BRAND
Spice oils



The finest spice oils can be recognized by the Pyramid Brand . . . the peak of quality at economy prices.

P&S experts, located in buying markets throughout the world, accept only the finest grades at the proper buying seasons.

Upon arrival here, they are reexamined and carefully analyzed by P&S technicians who properly evaluate them for meeting the needs of our discriminating American market.

Ask for the best . . . ask for "Pyramid" in these and many other oils:

ANISE	CLOVE	NUTMEG
BAY	CORIANDER	PEPPER
CARAWAY	DILL	PIMIENTO
CARDAMON	GINGER	SAGE
CINNAMON BARK	MARJORAM	THYME

P&S
POLAK and SCHWARZ
INCORPORATED
667 WASHINGTON ST., NEW YORK 14, N. Y.
Offices: Chicago, Ill.; Cinn., Ohio; Los Angeles, Calif.; Toronto, Can.
Plants: Teterboro & Guttenberg, N. J.; Culver City, Calif.; New York, N. Y.

BOOKS

(Continued from page 44)

For the laboratory and research man, the chapter on analysis may be of particular interest inasmuch as continuous analytical instruments as used in production processes are considered. Although some of the discussions are somewhat brief, the subjects covered include: heat of combustion; thermal conductivity; electrical conductivity; change of volume; weight; heat of reaction; color of reaction; electrochemical reaction; magnetism; infrared analysis; ultraviolet analysis; mass spectrometry; refraction; pH; conductivity; dielectric constant; and, turbidity.

Instruments for Measurement and Control is a useful source of reference for the food technologist and production engineer. It also provides a better understanding of the development of instrumentation and of the tasks to which instruments can be put for management and nontechnical personnel.

WILLIAM B. ESSELEN
Amherst, Mass.

FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

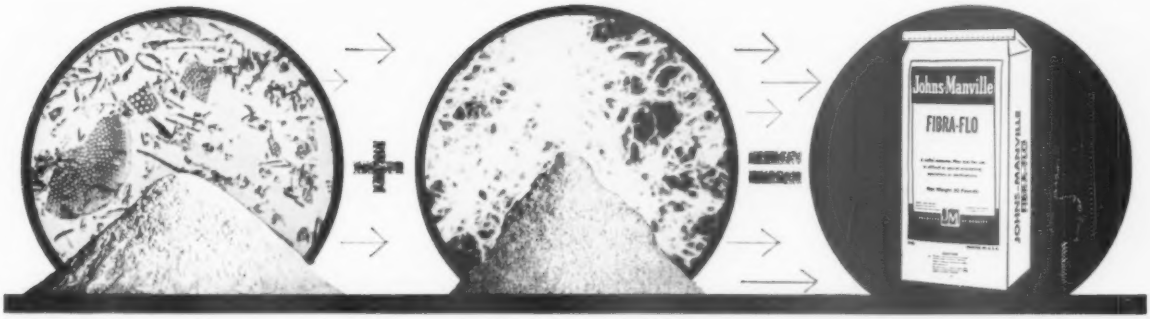
1956

February 6-17	Ice Cream Short Course, North Carolina State College, Raleigh, North Carolina
February 21-24	Dairy Laboratory Short Course, School of Agriculture, North Carolina State College, Raleigh, North Carolina
March 13-14	Fourth Annual Dairy Engineering Conference, Kellogg Center, Michigan State University, East Lansing, Michigan
March 15-16	First International Symposium on Physics in the Food Industry Plaza Hotel, San Antonio, Texas
March 16-17	**Fourth Annual Food Technology Short Course for 1956, Campus of the University of Missouri, Memorial Student Union, Columbia, Missouri**
April 8-13	One hundred and twenty-ninth National Meeting of the American Chemical Society, Dallas, Texas
April 11-13	Annual Meeting of the Research and Development Associates, Food and Container Institute Inc., Hotel Statler, Boston, Mass.
April 23-25	Forty-seventh Annual Spring Meeting of the American Oil Chemists' Society, Houston, Texas
May 30-June 2	**Sixth Annual Convention of the Australian Sections of IFT, Ritz, Leura, N. S. W., Australia**
June 10-14	**Sixteenth Annual Meeting of the Institute of Food Technologists, Hotel Jefferson, St. Louis, Missouri**
June 18-22	International Congress on Food Distribution, Rome, Italy

Johns-Manville announces a new line of Filter Aids

FIBRA-FLO

For . . . *Exceptional Clarity, Cake Stability, Labor and Maintenance Savings*



DIATOMITE—Celite's unique particles provide highest clarity at fastest flow rates.

ASBESTOS—Fibrous asbestos particles provide greater cake stability and adsorption.

FIBRA-FLO—In Fibra-Flo you get the advantages of both asbestos and diatomite.

Combining the excellent adsorption properties of selected and processed asbestos fibres with the high flow rates of Celite* diatomite, Johns-Manville offers this PRE-MIXED filter aid to those requiring superior filtration of liquids.

Johns-Manville, the world's largest producer of both Asbestos AND Diatomite, selects materials from each of its mines and carefully blends them into a number of grades. In addition, strict uniformity is maintained for each grade so that you may choose the exact mixture you require, relying on this uniformity for all future orders.

Fibra-Flo is now available in carload quantities. Use the coupon below to get further information.

FIBRA-FLO offers the following advantages to your filtration process:

1. Improved clarity more quickly obtained.—Increased production.
2. Filter cake more easily parted from screen.—Labor savings.
3. Better protected septums, less plugging.—Labor and maintenance savings.
4. Screen imperfections can be coated.—Longer service.
5. Asbestos can adsorb undesirable dissolved solids.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville

FIBRA-FLO

asbestos-diatomite filter aids

A product of the Celite Division

*Celite is Johns-Manville's registered trademark for its diatomaceous silica products.

Johns-Manville, Box 60, New York 16, N. Y.
(In Canada: Port Credit (Toronto) Ontario.)

☐ Please send further information on Fibra-Flo
☐ Please have Celite technical man call for appointment

I am interested in the filtering of_____

_____ with the following equipment

_____

Name_____ Title_____

Company_____ Address_____

City_____ Zone_____ State_____

. . . in the public interest

The Navy's 1955-59 Antarctic research expedition under the leadership of Rear Adm. Richard E. Byrd (expedition officer in charge) and Rear Adm. George Dufek (task force commander) left the East Coast in November with provisions adequate to feed shore-based parties for two years. New developments in concentrated foods, powdered foods, and dehydrated foods, as well as thick, fresh-frozen sirloin steaks are expected to contribute to the expedition's success. Dried fruit, included in the special Trail Rations, will be protected by a special package using pouch paper coated with polyethylene and laminated to aluminum foil. Each pouch is printed with contents and preparation directions by Vanant Products, Tomah, Wis., and the dried fruit is packaged by Wexler Corp., Minneapolis. The pouch paper is made by Riegel Paper Corp., 260 Madison Ave., New York 16, N. Y.

◆ ◆ ◆

Food technologists and canning experts are on the threshold of unlocking secrets that will provide housewives with food aerosols for spreads, salad dressings, condiments, and sauces that can be stocked on kitchen shelves without refrigeration, according to Mr. W. Earl Graham, research manager of the can division of Crown Cork & Seal Co., Baltimore. The easier-to-dispense and easier-to-store products will stimulate consumption of what have been perishable, refrigerated items up to now, he pointed out. Recent developments in aseptic canning, in combination with pressure packaging advances, offer the keys to development of the non-refrigerated aerosols for semi-solid foods, according to the researcher. Scientists are marshalling their forces to solve the problems of getting semi-solid products into the proper texture and consistence for dispensing, and of effecting compatibility between food and propellents, he added.

◆ ◆ ◆

A fund of more than $900,000 for grants to over 100 selected universities and colleges in its annual program of aid to education was announced by the Du Pont Company, Wilmington, Del. This support, for the next academic year, is an increase over the $800,000 in gifts made for this year. All of the increase and nearly half of the entire new program are for improvement of teaching in colleges and universities and in high schools. The grants will support science and mathematics, as well as other subjects. The change in emphasis in the company's effort reflects the changing needs of the schools. At the same time, grants for fellowships in science, which once made up the entire program, and for fundamental research are being continued.

◆ ◆ ◆

Food and grocery consumption in 1955 set a new high record, and even further increases are in prospect for 1956, according to Mr. Paul S. Willis, president, Grocery Manufacturers of America, 205 E. 42nd St., New York 17, N. Y. "Total consumer food expenditures in 1955 have apparently established a new all-time record of about $68 billion, compared with $64½ billion in 1954 and $16 billion in 1939," he said, "and with population continuing to grow, and with consumer income on the increase, food spending can readily top $71 billion in 1956. Mr. Willis foresaw distinct possibility of a $100 billion annual food expenditure by 1965—provided grocery manufacturers and distributors would work even "harder and smarter" to meet the increasingly effective competition of other industries which are bidding so vigorously for a larger share of the consumer's dollar. He noted that grocery manufacturers are spending about $100 million a year on products and market research to bring the homemaker new and better groceries. "About one-third of today's grocery department sales are on items that did not exist ten years ago, or were there only in token quantities," he pointed out. Leading the sales parade are new grocery products with "built-in kitchen services."

◆ ◆ ◆

According to the Stockpile Report to the Congress, January-June, 1955, by Director Arthur S. Flemming, Office of Defense Mobilization (issued in October), by the end of fiscal year 1956 the tin stockpile "will contain or have available sufficient metal to meet the long-term objective—enough to meet any foreseeable emergency. . . ."

◆ ◆ ◆

The Supplemental Unemployment Benefit Plan developed by American Can Company is not a "guaranteed annual wage" plan but one which provides an incentive to management to stabilize employment, according to Mr. R. W. Edison, Canco labor relations expert. He stated that "employment stabilization" was a primary objective of the controversial SUB plan. About 25,000 Canco hourly rated employees now are covered by its provisions. He said the plan is not inconsistent with existing state unemployment benefit laws. "It is no more incompatible with the provisions of these statutes than private pension plans are incompatible with Federal Social Secu-

(Continued on page 50)

They all taste better if you make 'em with '999'

Morton '999' Salt insures uniform flavor and quality in processed foods for two reasons:

1. Morton '999' is *guaranteed* always to contain more than 99.9% pure sodium chloride. The remaining 0.1% (or less) is a neutral inert sodium salt—and never bitter calcium or magnesium compounds.

2. Morton '999' Salt is produced by vacuum pan evaporation to assure you a salt that is clean, free-flowing... evenly soluble. It has a more constant weight per volume ratio which insures more accurate salt measurement.

For more information about Morton '999' Salt—and about Morton service and technical help—write this week to:

MORTON SALT COMPANY

Industrial Division, Department TL-2
120 South La Salle Street, Chicago 3, Illinois

FOOD INDUSTRY TOPICS

(Continued from page 48)

rity," he explained, adding that SUB merely provides employes with additional security over and above that provided by the state programs. Mr. Edison pointed out that the Canco SUB plan was worked out on the basis of Canco requirements alone, and would not necessarily be suitable for adoption by any other company. He said industries must painstakingly survey their individual requirements and responsibilities in determining whether or not such a plan, or an adaptation of it, would be feasible.

◆ ◆ ◆

Top corporate executives in 1954 failed to get salary raises proportionate to those they gave their hourly workers. This is indicated by results of the sixth annual survey of top management compensation recently distributed to subscribers by the Executive Compensation Service of the American Management Assn., 1515 Broadway, New York 36, N. Y. Compensation paid to more than 25,000 high-ranking executives of more than 3,000 American and Canadian companies during the 1954-55 fiscal year increased by only 1.8%, on the average. This percentage refers to total compensation, which includes salaries, bonuses, and company contributions to retirement funds. For a comparable period, hourly rates paid to workers in manufacturing industries increased by 5%, according to Bureau of Labor Statistics figures. The latter percentage includes only wages, not fringe benefits. Results of the new survey, like those of the five previous studies, indicate that the fortunes of executive personnel are more directly tied to economic trends than are those of any other segment of the population.

◆ ◆ ◆

Yale University has announced purchase of a 1,000,000 volt Van de Graaff particle accelerator to be used in fundamental radiobiological research studies at the school. The unit, manufactured by High Voltage Engineering Corp., Cambridge, Mass., sole manufacturer of Van de Graaff accelerators, will be an important part of a program now being conducted under one of the university's research grants. According to Dr. Franklin Hutchinson of Yale's newly established Biophysics Department, the accelerator will be the basis of a study in use of ionizing radiation to determine structure and function of cell components.

◆ ◆ ◆

With vague terminology preventing a common understanding among packers and buyers on how to rate the qualities of kraut, a new, more objective method for grading was needed to improve the quality and the marketing of the product. A kraut packers research committee under the supervision of Dr. Carl S. Pederson of the New York State Agricultural Experiment Station began work six years ago to develop a new method. As a result of this liaison between industry and Government, the five chief grading factors used will include testing for flavor, color, cut, character, and defects. It is the industry's hope that the new standards will result in broader quality breakdowns for kraut sometime in 1956.

◆ ◆ ◆

Fifty years of progress by the food, drug, chemical, and cosmetics industries of the U. S. will be observed throughout 1956, with Dudley-Anderson-Yutzy, 551 Fifth Ave., New York City, serving as public relations counsel for the over-all commemorative program, national in scope. The year's series of meetings, activities, exhibits, and similar projects will be undertaken jointly and individually by consumer groups, federal and state government officials, trade associations, and firms within the several industries covered by food and drug legislation. The first federal food and drug law was enacted in 1906. Background data, project suggestions, and consultation will be provided to assist all interested organizations, individuals, and firms in carrying forward the commemorative program.

◆ ◆ ◆

A civil service examination has been announced for Dietetic Intern for filling internships paying $2,000 a year in VA hospitals in Los Angeles, Bronx, N. Y., Hines, Ill., Memphis, Tenn., and Houston, Texas. To qualify for these internships, applicants must have received a bachelor's degree from an accredited college or university and have completed courses of study in appropriate fields. No written test is required. Interns will be given a 12-month training course, after which they will be eligible for promotion to a Dietitian position with the VA, paying from $3,670 to $4,525 a year. Applications will be accepted through March 1, 1956, for the classes of interns beginning on July 1 or September 15, 1956. Applications must be filed with the Board of Civil Service Examiners, Veterans Administration, Washington 25, D. C.

. . . *things new under the sun*

A new, continuous infrared dispersive-type analyzer designed to continuously monitor and control liquid and gaseous process streams and an improved, high-resolution, continuous-flow paper electrophoresis apparatus are announced by Beckman Instruments, Inc. The Model 176 Dispersive Infrared Analyzer, combining the features of a precise, highly sensitive laboratory spectrophotometer with the heavy duty dependability of a commercial instrument, is especially suited for pilot plant operation due to versatility and easy adaptability in determining material balances and over-all yields. Another important application is in controlling the product purity from a fractional distillation column where its use enables greater throughput and more uniform product quality. Performance includes photometric accuracy to within 1% transmission, while drift is less than 1% a day. Write the firm's Beckman Division, Fullerton, Calif.

New methods of electrolyte feed and wide-range controls permit the new Spinco Continuous-Flow Pa-

per Electrophoresis apparatus to give maximum throughput under any required degree of resolution. Design efficiency also has been raised so that resolutions formerly requiring as much as 1,500 volt operation are made at one-third this value. Applicable to separation of all kinds of charged substances such as proteins, polypeptides, and amino acids, the unit also handles such organic substances as dyes and intermediates. In special cases, non-polar substances such as carbohydrates can be separated. The apparatus also is particularly useful for following organic reactions, and for immunochemical work. Write Spinco Division, Beckman Instruments, Inc., 704 O'Neill Ave., Belmont, Calif.

◆ ◆ ◆

The Oakite Hurriclean Gun—designed for steam cleaning efficiency, cool handling, and easy operation—has been introduced by Oakite Products, Inc., 19 Rector St., New York 6, N. Y. Revolutionary feature of this new solution-lifting steam gun is the **ingenious way in which the cleaning solution is used to protect the operator from the heat of the steam.** Where other devices have had separate tubes for solution and steam, the Hurriclean Gun uses a tube within a tube—steam passing through the insulated interior tube, solution through the exterior. Another feature is the sealed rotary joint which makes it possible to rotate the nozzle without twisting or wrestling with heavy solution or steam hose. Operator fatigue is reduced further by designing the Gun so the thrust of the steam is taken up between the handles. The Gun needs only steam and solution hose, cleaning solution made up in a 50-gallon drum or other container, and 30 pounds of steam. It weighs only $6^3/_4$ pounds in its $3^1/_2$-foot length, and slightly more in the 5-foot size.

◆ ◆ ◆

Instantaneous drying of sample quantities of various solid and liquid materials in the laboratory is made easy with the new ERDCO dielectric oven. The standard model has an accurately rated output of 2 kw and is available with rated outputs up to 20 kw. Inside dimensions of the oven are 8″ by 8″ by 8″. Over-all dimensions are 25″ by 34″ by 63″. Manufactured by Erdco Engineering Corp., Addison, Ill.

◆ ◆ ◆

A new conveyor belt for the food industry—called PERMAGLOSS—is fabricated with a wonder plastic which has all the characteristics necessary for a perfect food handling belt, according to the manufacturer, The Mohawk Supply Co., Rm. 1267, Commercial Trust Bldg., Market St. at 15th, Philadelphia, Pa. Major features of the belt are: extremely smooth surface; high tensile strength; no stretch or contraction due to heat, moisture, or other cause; high tear strength and resistance to abrasion; resistance to heat

ACCESSORY NUTRIENT FACTORS

For the luxuriant growth of all lactic acid bacteria yeasts and molds assured by the use of

EXCHANGE BRAND ORANGE SERUM AGAR #77

(Dehydrated) a Complete Culture Medium

FORMULA — *Ingredients—when rehydrated on basis of 45 grams per liter of medium.*	
Orange juice serum solids	12.6g*
Agar (dry basis)	15g
Peptone	10g
Yeast hydrolysate	3g
Reducing sugars, total	8g
Sucrose, total	6g
Cysteine hydrochloride	0.001g

Buffered with 0.2 to 0.6g K_2HPO_4 to provide pH 5.5 ± 0.05 after sterilization.

**Equivalent to 100 ml 12° Brix orange juice serum.*

STANDARDIZED for uniformity and stability.

POTENTIAL APPLICATION—Orange Serum Agar as an all-purpose medium has a wide application to the bacteriologist and microbiologist in the milk, fruit pickling, food, bottling and fermentation industries.

Available in 1 lb. bottles through your laboratory supply house.

Sunkist Growers

PRODUCTS DEPARTMENT

Exchange

PHARMACEUTICAL SALES • ONTARIO, CALIFORNIA

FOOD INDUSTRY TOPICS

and cold within a range of −140° F. to +300° F.; complete resistance to moisture, oils, grease, solvents, all acids except Nitric, and all alkalis except Ammonium Hydroxide. A specially designed joint makes this vulnerable part of the belt as strong as the material itself. PERMAGLOSS may be furnished in any length, and in any width to 36".

◆ ◆ ◆

A new rotary film evaporator incorporating many new features is available from Labline, Inc., 3070-82 W. Grand Ave., Chicago 22, Ill. Suitable for use with flasks of 100 cc. and larger, FLASH-VAC is ideal for separating heat and air sensitive solutions, as well as separating concentrated solutions of high boiling point solvents such as water and Butanol. Biological extracts and solvents such as water and dimethylformamide can easily be processed. Unit consists of stainless steel sleeve with "O" ring pulley, 24/40 taper, vacuum tube, oilless bearing, and fully enclosed induction motor with "V" belt drive. Assembled in a packaged unit. All parts are 18-8 stainless steel. Write for Bulletin No. 5100.

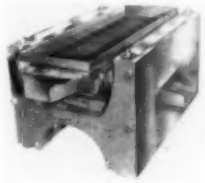
◆ ◆ ◆

An innovation in "bacteria-free" air conditioning for laboratories has been developed at the University of California Bacteriological Research Center, Berkeley. The system claims 99% bacteria free air when used with an air diffuser manufactured by the Pyle-National Co., Multi-Vent Division, 1334 N. Kostner, Chicago, Ill. Basis of the system's success is the low-velocity air diffuser which allows more time for germicidal lamp rays to have an effect on air-borne bacteria as air moves into the lab from the diffuser. In addition to furnishing sterile air to the labs, the Multi-Vent air diffusers provide draftless air conditioning and even temperature control. Working in cooperation with the Pyle National Company were General Electric and Westinghouse, who manufacture the germicidal lamps, and who determined the wattage necessary with the low velocity air diffuser.

◆ ◆ ◆

New CHIP-FREEZE automatic ice flaking machines introduced by the Cold Corporation of America, 1371-89 N. North Branch St., Chicago 22, Ill., a division of Shelley Industries, are available in such decorator colors as shocking pink, baby blue, orchid, canary yellow, mint green, and white. Sanitary feature is the production of new ice at top of unit, eliminating the possibility for accumulation or decay of old ice. Ice chips are delivered at waist level. The new CHIP-FREEZE delivers 560 pounds of ice daily, and produces ice flakes for as little as 2¢ per bushel.

◆ ◆ ◆



Where greater outputs in straining operations are required than within the range of 1,000 to 15,000 gallons per hour, without installation of a multiplicity of units, a new and much improved version of their famous Separator is offered by Russell Constructions, Ltd., Russell House, 8 Adam St., London, W.C. 2, England. The new Streamline Model Separator has about double the capacity of output compared with the standard model, yet has almost the same over-all dimensions (5'7" long by 2'9½" wide by 3' 8½" in height). The unit is now mounted in a heavy box section frame which has the effect of preventing escape of the gyratory effects to the static part of the machine, eliminating the necessity for any special foundation work when installing the unit.

The English firm also announces availability of a paper, "Food Hygiene in Sieving and Straining," by its managing director, Mr. Justin Hurst.

◆ ◆ ◆

A new single-use container for liquids or semi-solids is available through the Unette Corp., 280 Madison Ave., New York City. The Unette dispenser, at left, made of thin-wall extruded Saran, is a slender, transparent, pliable tube temporarily sealed at the dispensing end with a specially prepared compound. The seal is designed to withstand ordinary pressures, but opens with a firm squeeze. The firm also manufactures a Touchette applicator, right above—a Unette dispenser with a cotton cap affixed to its dispensing end. A squeeze releases its liquid content which is absorbed by the cotton and is ready for immediate application. Services of the firm include packaging products in Unette dispensers and bulk shipping them to destination. Dispensers can be manufactured in sizes desired.

◆ ◆ ◆

A sintered filter of unique design and remarkable versatility has been introduced by Purolator Products, Inc., Rahway, N. J. Capable of handling fluids ranging up to 1000° F., the filter can take flow rates comparable to any high temperature filter in existence with lower differential pressures and a better degree of filtration, according to company engineers. Made of sintered metal, the filter removes particles as small as one micron from a wide range of fluids, including such "hot" materials as nitric acid, hydrochloric acid, sulphuric acid, phosphoric acid, and

strong alkalies. Filters of stainless steel, monel, and other metals can be made as required.

◆ ◆ ◆

Production of an **auxiliary tank unit,** designed for heavy volume work in general building maintenance where large wet or dry tank capacity increases job efficiency, is announced by Premier Company, 755 Woodlawn Ave., St. Paul 1, Minn., and 35 Gerrard St. West, Toronto 2, Canada. The kit includes all attachments necessary to convert a standard 30-gallon waste can into an auxiliary tank.

◆ ◆ ◆

A portable foot warmer for employees on the production line, in the office or laboratory, or on the sales floor is available from General Industrial Co., 5750 N. Elston Ave., Chicago, Ill. The 14" by 21" neoprene rubber mats use less power than a 75-watt light bulb, reportedly increase employee efficiency and cut down absenteeism due to colds. Mats are priced at $7.95 each, and will be sent postpaid if you mention this publication when ordering.

◆ ◆ ◆

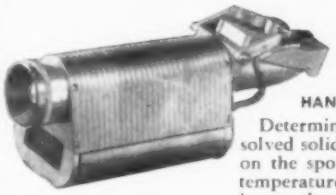
To help industry cut its steam costs, The Patterson-Kelley Co., Inc., East Stroudsburg, Pa., has designed **a new packaged boiler return system** that utilizes heat energy from high-pressure condensate to preheat incoming water for processing. The unit also reheats condensate, plus make-up water, to near steaming temperature and returns it to the boiler. Comprising a condensate cooler and receiver, feedwater heater, all controls, pumps, piping, and accessories, the new p-k unit comes completely packaged, ready to be set up and piped to steam, condensate, and water lines. Patterson-Kelley now furnishes its packaged systems in 11 sizes—ranging from 30 to 300 boiler hp. Larger capacities also are available.

◆ ◆ ◆

A new series of "microvac" rotary mechanical vacuum pumps incorporating a thoroughly proved and service-tested gas ballast feature plus an exclusive oil-purging device has been developed by F. J. Stokes Machine Co., Inc., 5500 Tabor Rd., Philadelphia 20, Pa. The combination of gas ballasting and the oil-purging feature prevents contamination of the pump's oil by condensation of any vapor in the system being evacuated. From this numerous advantages ensue. The oil lasts longer, requires less frequent renewal. Clarifiers or purifiers become unnecessary except where extremely large quantities are being handled because the oil does not become impure and emulsify. Even if water- or gas-contaminated oil should be introduced into the pump, the oil soon purges itself of such vapors when the oil-injec-

Make Your Work Easier

with these QUALITY INSTRUMENTS

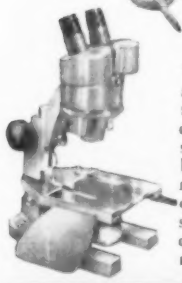


HAND REFRACTOMETER

Determines percentage of dissolved solids, especially sucrose, on the spot, instantly! Built-in temperature compensation eliminates thermometers and temperature correction tables. Built-in light source and leather carrying case make instrument portable, useful anywhere.

ABBE REFRACTOMETER

The quality control instrument for determination of purity and total dissolved solids in food products. Available with standard Abbe, Sugar and High Index scales.



STEREOSCOPIC MICROSCOPE 25LF

To detect impurities and adulterants in food. Long working distance—three-dimensional image—inclined binocular body. Removable base allows examination of large specimens. Accommodates ungraduated mechanical stage.

BACTERIAL COUNT MICROSCOPE N15MLHYZ

Permits rapid estimate of number of bacteria present in fluid milk. Factory precalibrated field offers the quickest count because permanent field sizes are assured.

DARKFIELD QUEBEC COLONY COUNTER

For estimating bacterial concentration. Comfortable to use, easy on the eyes — glareless indirect light floods the specimen from all angles. Controlled magnification achieved by 1.5 lens which completely covers the culture.

American Optical — INSTRUMENT DIVISION, BUFFALO 15, NEW YORK

Dept. B-190 Please send me information on

☐ Colony Counter ☐ Hand Refract.
☐ Abbe Refract. ☐ N15MLHYZ
☐ 25LF

Name

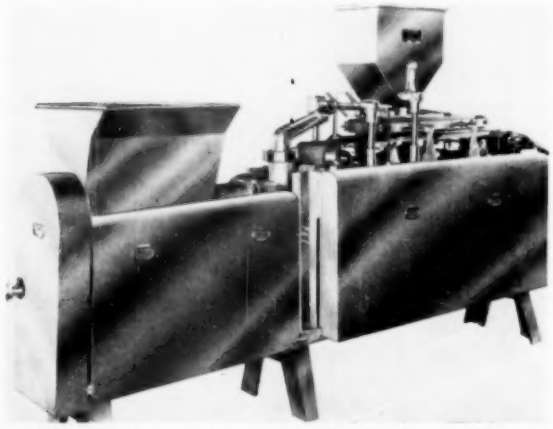
Address

City State

FOOD INDUSTRY TOPICS

tion feature, which is exclusive with the new Stokes pumps, is in operation.

◆ ◆ ◆

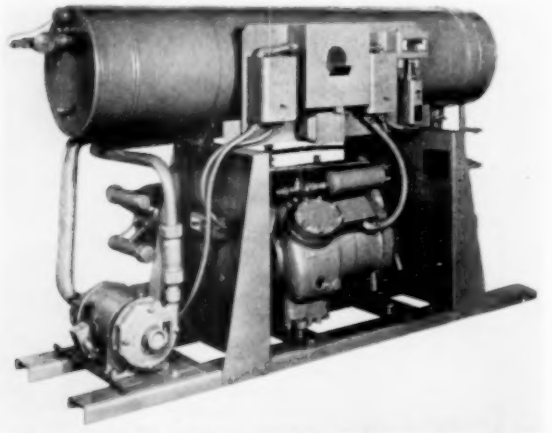


Alba Engineering Co., Inc., Alba St., Los Angeles 58, Calif., has announced a change in the drive system of their Cut-Rol machine. Reengineered, the new drive gives trouble-free operation. The Cut-Rol machine extrudes, cuts, rolls, and dusts meat mixture into balls of uniform size and weight ready for braising or canning. Speeds up to 350 meat balls per minute and weight accuracy are its special features.

◆ ◆ ◆

Dull-chrome finished vernier slides are the latest improvement in the well-known Mauser Vernier Caliper, made by George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y. The caliper, best known as No. 101, only recently was changed to all stainless steel, making it rustproof against atmospheric conditions and perspiration from hands. Price remains at $14.75.

◆ ◆ ◆



Six new Acme Flow-Cold packaged liquid chillers (as illustrated), ranging in capacities from 3 through 20 tons have been announced by Acme Industries, Inc., Jackson, Mich. The new, compact units require no cabinet or other special encloser as sound-proofing. Quiet operation is assured by the dynamically and statically balanced compressor. Controls are engineered for fast, accurate matching of chiller operation to the cooling load, and provide full protection against accidental freeze-up of the unit. A complete new line of Acme Flow-Temp Remote Room Conditioners, available in basic capacities of 200, 400, and 600 CFM, also is announced by the firm.

◆ ◆ ◆

A combination constant temperature bath and circulating system for both high and low temperature operation is offered by William B. Johnson & Associates, Inc., Empire State Bldg., New York 1, N. Y. With a temperature range from −30° C. to +75° C., the Johnson Forma Bath can maintain an accuracy of 0.02° C. The versatile unit with adjustable shelf can be used as a liquid bath, cold storage cabinet, or, by one valve turn, bath medium may be circulated outside cabinet for temperature control of chromatographic columns, thermal sensitive instruments, sinks or other containers where constant temperature is desired. Stainless steel throughout, the unit comes mounted on casters.

◆ ◆ ◆

A device that permits **remote selection of numbers or letters to be printed on strip charts** has been developed by Royson Engineering Co., Hatboro, Pa. The unit, called the RI–3 IDENTICHART, is extremely useful for identifying range, chart speed, channel number, or other variation that needs to be identified when the chart is reviewed. The device can have two print wheels if desired, each independently set by separate, remote switches. The printing pulse causes the device to print whatever characters have been selected. The unit does not interfere with or obscure the recording procedure. The RI–3 can be obtained in easy-to-install kit form. Other models available for printing time, serial numbers, etc.

◆ ◆ ◆

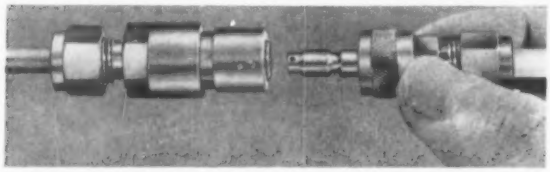
A new method of control in manufacturing processes, **through use of wavelength absorption from a continuous flow of materials or finished products,** now is possible through use of SPECTROSTATS, developed by Kaye Development Co., South Norwalk, Conn., a subsidiary of Atomic Instrument Co., Cambridge, Mass. Gasses, liquids, slurries, sheets, or a flow of unit solids may be monitored by the Kaye method, which can sense deviations in absorption bands within pre-selected limits. The SPECTROSTAT provides continuous sampling of any of these forms, and indicates the direction of deviation beyond the set limits by a visual and or audible warning. A 50-millivolt proportional output provides direct process control. The SPECTROSTAT consists of an integrated group of unitized components which may be assembled to perform the function of absorption band deviation measurement in a number of different ways. Observations may be made in the range from ultra-violet through near infra-red.

◆ ◆ ◆

A labor-saving, low-cost solution to an age-old industrial problem—maintaining and upgrading wood, metal, and masonry surfaces in plant facilities—is announced by The Glidden Company with introduction of **a new, 100% solids resin coating,** named Glid-Iron. In addition to having excellent adhesion to wood, metal, and concrete, Glid-Iron is highly resistant to chemicals. The coating may be applied by

spray, brush, roller, or squeegee in any mil thickness, $^1/_{16}$" to $^1/_2$" if desired. Application time for a 10' by 40' area is 20 to 30 minutes with an undercoating gun, and two to four man hours by other application methods. Application cost is set at 15 to 19 cents per square foot, compared with other methods that range up to 35 cents per square foot. Glid-Iron will withstand extreme temperature ranges—from −20° up to +212° F. Additionally, it is skid-proof, even when wet with rain or snow, and nails may be driven through the film without it chipping. The coating may be supplied in any color. Write the firm c/o Nelson B. Moore and Associates, 630 National City—E. 6th Bldg., Cleveland 14, O.

◆ ◆ ◆

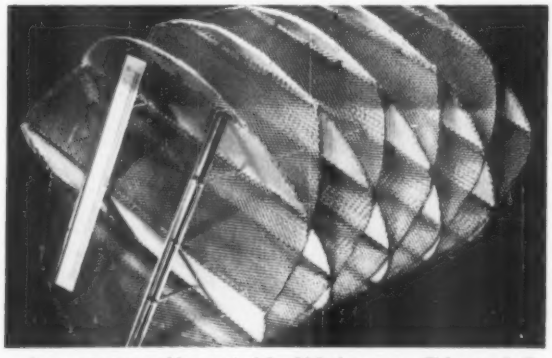


The new Swagelok Quick Connect Fitting, manufactured by Crawford Fitting Co., 884 E. 140th St., Cleveland 10, O., is so easily connected and disconnected that a thumb and finger are the only "tools" needed. The shutoff valve in the fitting acts as a positive seal to prevent any leakage during the connecting or disconnecting operation. Internal design allows freer flow than is possible with ordinary fittings of similar type. On the exterior, the fittings are streamlined for convenience in handling. Used with plastic tubing and metal tubing, the fittings are available in all metals, in sizes to fit ordinary applications, and in three types: tube-to-tube with Swagelok Ends; tube-to-pipe with one Swagelok End; bulkhead, either tube-to-tube or tube-to-pipe.

◆ ◆ ◆

A new, light-duty electraulic lifter is being introduced by the Colson Corp., Elyria, O. It has a load capacity of 1,000 pounds, and is equipped with a ¾ hp. motor with magnetic fused starter. Lift height is 5'8"; lift speed is 15 feet per minute. The lifter's short 39-inch length affords ease of handling and maneuverability. The platform is 24" by 24". Over-all weight is 455 pounds. The unit also is available in battery powered, hand hydraulic, and hand winch models.

◆ ◆ ◆



A new tower packing material which increases efficiency of distillation, absorption, scrubbing, and stripping is available from S. Blickman, Inc., Weehawken, N. J. Called Spraypak, its use can increase throughput 2 to 3½ times that of existing bubble tray or ring-packed towers. Spraypak was developed by the Atomic Energy Research Establishment, Harwell, England, for large-scale separation of hydrogen isotopes by distillation of water. Because of the low value of the separation factor for this system, 1.026 at 100° C., the primary requirements were a very large capacity, H.E.T.P. values of 2 feet or less which are substantially independent of the diameter, and low cost. The material fully meets these requirements, and now is available for general industrial use for distillation columns, absorbers, and similar applications.

Open new markets with the help of EASTMAN antioxidants

Ever develop a food product which could be given only local distribution—or perhaps couldn't be marketed at all—because of limited stability? If so, it probably contained an oxygen-sensitive ingredient, such as an oil or a fat, which caused the trouble.

Let Eastman help you combat this problem with its complete line of Tenox antioxidants. Our staff of food technologists would welcome the opportunity of working with you on the proper use of these antioxidants. Assisting other food processors in this manner, we have helped send many fine products from the laboratory shelves to the market place.

Since Eastman manufactures the widest range of antioxidants, we have no axe to grind in favor of any one. You can be certain our recommendation will represent the most economical and effective stabilization possible against oxidative deterioration.

For more information about Tenox, write to Eastman Chemical Products, Inc., Kingsport, Tennessee—a subsidiary of Eastman Kodak Company.

Tenox Eastman food-grade antioxidants

FOOD INDUSTRY TOPICS

. . . *the literary corner*

Three important articles in the field of health hazards with frozen foods are highlighted in the November 15, 1955, *Information Bulletin* of The Refrigeration Research Foundation, 200 Midland Bldg., Colorado Springs, Colo. In the July-August 1955 issue of *Food Research*, M. A. Saleh and Z. T. Ordal of the University of Illinois report on their investigations into the possibility of botulinum toxin in frozen chicken a la king. In an article entitled "Significance of Enteric Bacilli in Foods," appearing in *American Journal of Public Health*, September 1955, Dr. Gail M. Dack of the University of Chicago discusses the public-health significance of coliform organisms. The third article, a review of the bacteriological problems of frozen foods—particularly precooked—was prepared by Drs. R. P. Straka and J. L. Stokes of the Western Utilization Research Branch, USDA, at the request of Mr. H. C. Diehl, TRRF director. It will appear in an early issue of *Quick Frozen Foods*.

◆ ◆ ◆

Lectures from the 1955 AOCS Short Course at the University of Illinois, covering existing methods plus new developments with infrared, with chromatography, fractionation, etc., are available at $3.00 per copy from American Oil Chemists' Society, 35 E. Wacker Dr., Chicago, Ill.

◆ ◆ ◆

Three types of evaporation equipment for chemical, food, petroleum, plastic, and drug process industries, operating over the range from volatile solutions to powder with infinitely varied control, are described in Bulletin No. 125 published by the Process Equipment Division of Rodney Hunt Machine Co., Orange, Mass. Operating principles, specifications, and product applications of the Turba-Film Evaporator, the Turba-Film Floating Blade Evaporator, and the Rodney Hunt-Luwa Spray Dryer are presented. In addition, the bulletin contains details on the firm's new Floating Blade Model Turba-Film Evaporator, recommended for reduction of solutions from which the intermediate product is to be a mixture of crystals and liquor.

◆ ◆ ◆

The completely new 1956 Reference Guide to Dow Corning silicone products, half again as large as last year's at 12 pages, describes almost 150 of the most generally used silicone products, 18 of which were introduced within the last year. The products again are grouped by physical form (fluids, compounds, greases, resins, and rubbers) and cross-indexed by usage (dielectrics, defoamers, damping media, etc.), enabling them to be located by what they do, as well as by what they are. Write Dow Corning Corp., Midland, Mich.

◆ ◆ ◆

Two new folders tell applications, sizes, properties, and fittings of Alpha PVC Corrosion-Resistant Pipe. Released by Alpha Plastics Inc., 15 Northfield Rd., West Orange, N. J., the first folder shows fully detailed reference information for proper selection of its unplasticized rigid PVC pipe, where high chemical resistance and/or high impact resistance is desired. The two types, Alpha 101 and Alpha 102 are described. Also introduced is the manufacturer's new, pressure-rated Schedule PR-150 rigid PVC pipe which offers the same working pressure in every size, from ½" to 4". Companion folder describes and illustrates threaded and socket solvent cement fittings recommended for use with the Alpha line of ½" to 4", 101 or 102 rigid PVC pipe.

◆ ◆ ◆

The advantages of continuous separation for the food processor are described and illustrated in a new 4-page bulletin issued by Merco Centrifugal Co., 150 Green St., San Francisco 11, Calif. Flow diagram illustrates operation of Merco units, incorporating the exclusive Merco Return Flow principle which insures a uniform output by preventing a build-up of stagnant solids at the rotor's periphery. Illustrated chart shows how Merco units accomplish any one of five basic food processing separations: classification, concentration, clarification, washing, soluble recovery.

◆ ◆ ◆

Recent findings on the filtration-extraction process for oilseeds, originated by research workers at the Southern Utilization Research Branch, USDA, have been published in a series of nine reprints, copies of which may be obtained without cost by writing to the Southern Regional Research Laboratory, 2100 Robert E. Lee Blvd., New Orleans 19, La.

◆ ◆ ◆

The privacy enjoyed by termites in out-of-the-way places may be a thing of the past, according to *Orkin Talkin* for November 1955, published by Orkin Exterminating Co., Inc., P. O. Box 647, Atlanta, Ga. Use of a microsonic detector, developed at the University of California, is said to permit quicker and easier detection of hidden infestations. When a termite operator inspects a structure for infestation and taps on floors and sills with his screwdriver, termites begin a quick rapping sound with their heads—against each other and against wood—to warn others in the colony that danger is near. Use of the unit requires a highly trained operator who can recognize these warning sounds, more readily detected than normal work sounds of the colony. The unit employs a selector system in which a wide range of sounds are detected. The selector can be used to eliminate almost all other sounds while leaving the termite warning signals audible.

◆ ◆ ◆

A current Service Bulletin, "Health and Employer/ee Efficiency," has been distributed to managements throughout the country as a guide in planning, developing, or expanding health programs, and is available from Occupational Health Institute, Inc., 6 E. 39th St., New York 16, N. Y. Companies com-

(Continued on page 58)

THE TWINS THAT WIN:

Fragrance

Flavor

BOTH FOUND IN ONE PRODUCT

ZIMCO® Vanillin

The Original Lignin Vanillin

ZIMCO's outstanding excellence and uniformity of flavor are the result of its exclusive, patented manufacturing process . . . developed through years of scientific experiment and research.

Remember . . . your best source of finished, ready-to-use flavors is your flavor manufacturer. Ask him about ZIMCO, the *Original* pure Lignin Vanillin. *There's nothing finer.*

Zimco Vanillin is noted for Quality and Dependability.

Consult Your Flavor Supplier

Sterwin Chemicals INC.
SUBSIDIARY OF STERLING DRUG INC.

1450 Broadway, New York 18, N.Y.
2020 Greenwood Ave., Evanston, Ill.

WORLD'S LARGEST SUPPLIERS OF VANILLIN

Shipments direct from plant, Rothschild, Wisc.
Emergency deliveries from: Atlanta, Dallas, Evanston (Ill.), Los Angeles, Portland (Ore.), Rensselaer (N.Y.), St. Louis, and Menlo Park (Calif.)

SANITATION

starts with

IN-PLANT CHLORINATION

From start to finish of your processing operation, *Wallace & Tiernan In-Plant Chlorination* will keep your sanitation problems to a minimum by:

Eliminating slime formation on equipment and in work areas

Retarding bacteria growth

Greatly reducing offensive odors

For information on how In-Plant Chlorination can help solve *your* sanitation problems, write today to our Foods Division.

WALLACE & TIERNAN
INCORPORATED
25 MAIN STREET BELLEVILLE 9, N. J.

I-46

FOOD INDUSTRY TOPICS

(Continued from page 56)

plying with standards for medical service in industry set by the Industrial Medical Association will be certified by the Institute (a non-profit organization) and receive the OHI Certificate of Health Maintenance.

◆ ◆ ◆

Variations in results achieved in machine dehairing of hogs long have constituted a troublesome problem in the meat packing industry. Research by the American Meat Institute Foundation, 939 E. 57th St., Chicago 37, Ill., has established that efficient machine dehairing can be achieved through proper control over the temperatures in the scalding vat and over the length of the period that hog carcasses are allowed to remain in the scalding water. Foundation Bulletin No. 23, "Important Factors in Effective Dehairing of Hogs and Improving Quality of Skins," reports the results of this research.

. . . *meeting hall and conference room*

Five thousand different pieces of equipment, products, and services, valued at $4 million, to help American industry maintain its productive capacity, were displayed January 23-26 at the Plant Maintenance & Engineering Show at Convention Hall, Philadelphia. The show was accompanied by a 3-day conference at which 26 aspects of factory upkeep were discussed. Clapp & Poliak, Inc., New York exposition management firm, 341 Madison Ave., produced both events.

◆ ◆ ◆

Dodge & Olcott, Inc., was one of eight firms and institutions, each more than 100 years old, elected to the newly formed Greater Paterson Chamber of Commerce Century Club at the CC's 48th annual dinner meeting November 16 in Paterson, N. J. In the photograph, dinner chairman Wm. W. Evans, Jr., left, presents Century Club Plaque to Mr. Brian McCabe, center, and Mr. Wm. Rosenberger of the D&O Hawthorne, N. J., plant.

◆ ◆ ◆

Magnus, Mabee & Reynard, Inc., 16 Desbrosses St., New York 13, N. Y., now celebrating its Diamond Jubilee, was honored at a dinner meeting at the Hotel Pierre, New York City, on November 17, by The Newcomen Society in North America, an organization which centers its work in the history of material civilization and the perpetuation of the best traditions of England and America. In his after-dinner address, "Magnum Opus: A World Treasury of Fragrance and Flavor" (published in booklet form by Princeton University Press), Mr. Percy C. Magnus, president of MM&R, unfolded the growth and achievements of the firm which draws its raw materials from Australia to Zanzibar, and which supplies its products to no less than 80 industries in half a hundred countries.

. . . *building up and branching out*

Acquisition of White Cap Company, Chicago, leading manufacturer of vacuum-sealed closures, by Continental Can Company, Inc., has been approved by directors of both firms, and will become effective upon completion of routine formalities. The November announcement, made jointly by Gen. Lucius D. Clay, chairman of the board of Continental, and Mr. Geo. P. White, chairman of the board of White Cap, stated that the business of White Cap Co., which will become a subsidiary of Continental, would be carried on unchanged by the present White Cap management.

◆ ◆ ◆

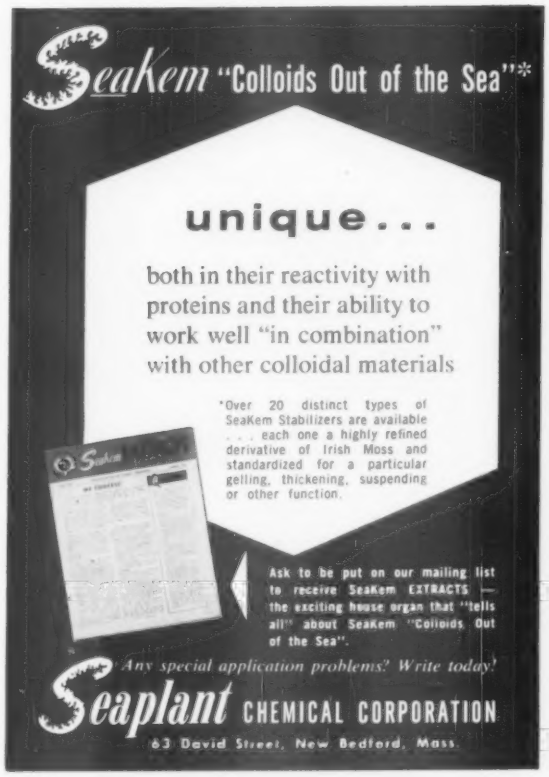
Fritzsche Brothers, Inc., New York City, announces removal of its Boston office from the Statler Bldg. in mid-town Boston to 661 Washington St., Norwood.

Mass., as of December 1. The increasing shift of industry away from congested metropolitan locations to more accessible suburban areas was a major consideration in the firm's decision to move its sales office.

David Michael & Co., Inc. 3742-63 D St., Philadelphia, Pa., has added 10,000 square feet of modern plant space to its present facilities to meet increasing demand for its vanilla powders, extracts, and flavoring syrups. A radically different method of extraction now being employed by the Michael Company is stated to result in a greater efficiency of extraction and a finer finished product than has been possible with traditional methods.

American Cyanamid Company, 30 Rockefeller Plaza, New York 20, N. Y. and The Formica Company announce negotiations whereby Cyanamid, one of the nation's leading chemical firms, will acquire the business and assets of The Formica Company, producer of laminated plastics. When the acquisition takes place, it is contemplated that Formica will continue to operate under its present management as an additional unit in the Cyanamid organization. Final agreement will be subject to approval of the Cyanamid board of directors and the stockholders and directors of Formica. The announcement also revealed plans by Formica for a $2½ million expansion program at the Evendale, O., plant, calling for a 20% increase in sheet laminating facilities. Construction will begin during spring 1956.

Reflecting industry's increased demand for trained instrument personnel, The Foxboro Company, Foxboro, Mass., is doubling the size of its Training and Education Center (architect's sketch above). Scheduled for completion early in 1956, the new building will accommodate 46 trainees, nearly double the previous capacity. Plans call for two 20-student classrooms, two laboratories where bench instruction and service training can be given, an instrument demonstration room, a conference area, and enlarged quarters for the expanding teaching staff. Completion of the new facilities will help reduce the customary waiting period for customers' men who enroll in the various courses of instruction. Nearly twice as many courses will be offered, including specialized training in electronic instruments and advanced forums for various industry groups, as well as the standard 3-week general courses which cover all phases of instrument work. Director of training is Mr. W. H. T. Furry.


SeaKem "Colloids Out of the Sea"*
unique...
both in their reactivity with proteins and their ability to work well "in combination" with other colloidal materials
*Over 20 distinct types of SeaKem Stabilizers are available . . . each one a highly refined derivative of Irish Moss and standardized for a particular gelling, thickening, suspending or other function.
Ask to be put on our mailing list to receive SeaKem EXTRACTS — the exciting house organ that "tells all" about SeaKem "Colloids Out of the Sea".
Any special application problems? Write today!
Seaplant CHEMICAL CORPORATION
63 David Street, New Bedford, Mass.

Consolidated Foods Corp., Chicago, in a move to diversify further its operations, has acquired through exchange of stock the Omaha Cold Storage Co., Mr. S. M. Kennedy, Consolidated Foods president, and Mr. H. C. Sheridan, chairman of the board of Omaha Cold Storage, announced jointly. Known also as Ocoma Foods Company and for its brand name "Ocoma," the Omaha Cold Storage Company was incorporated in 1899, and 1954 sales approximated $36 million. The firm is engaged in the raising, purchasing, and distribution of fresh and frozen poultry; the manufacture, distribution, and sale of frozen chicken, turkey, tuna, beef, and fruit pies; the procuring, manufacturing, and distribution of butter and eggs; the cold storage warehousing of food products; and the manufacture and sale of livestock feeds. On December 6, Mr. Sheridan was elected a director of Consolidated Foods.

The A. E. Staley Mfg. Co., Decatur, Ill., corn and soybean processors, had a net profit of $3,799,369 for the nine months ending September 30, Mr. A. E. Staley, Jr., president and board chairman, announced. Net sales for the period were $111,617,731, compared with $104,847,849 in the first nine months of 1954. Net profit for the period is equal to about 71% of 1954's $5,315,176 net profit. Mr. Staley pointed out that supplies of corn and soybeans were adequate

FOOD INDUSTRY TOPICS

during the period, and indications are that with near record harvests, the supply of grain again will meet all normal demands.

◆ ◆ ◆

The following news items have arrived from Chas. Pfizer & Co., Inc., 630 Flushing Ave., Brooklyn 6, N. Y.: (1) establishment of the Pfizer Northwestern Distribution Center, located on a 2-acre site at 3333 N.W. Industrial St., Portland, Ore.; (2) establishment of the $4,500 Pfizer Post-Doctoral Fellowship in Microbiology at the Rutgers University Institute of Microbiology; (3) an advance in the prices of citric acid, tartaric acid, and certain gluconic derivatives, due to increased manufacturing costs; (4) introduction on a commercial scale of methyl vinyl ketone, a highly reactive chemical intermediate for the manufacture of plastics, adhesives, drugs, and chemical specialties; (5) introduction commercially of a coated form of ascorbic acid (vitamin C) for use in the manufacture of straight vitamin C tablets and multivitamin preparations; (6) a series of personnel promotions and changes which find Mr. Paul E. Weber (IFT member) new sales manager of the firm's Chemical Sales Division, Mr. H. Chandler Smith assistant to the assistant sales manager of the company, Mr. John E. McVeigh Eastern Regional Manager, Mr. Jack D. Langlois Food & Beverage Department manager, and Mr. Robert D. Campbell mid-Western region sales representative.

◆ ◆ ◆

The new engineering building of the Fuller Company, Catasauqua, Pa., a subsidiary of General American Transportation Corp., located near the firm's main plant and office, houses 157 engineering personnel who previously have been located at seven different places in Catasauqua. Fuller manufactures a complete range of products for pneumatic conveying of dry granular and pulverized materials for the brewery, bakery, pulp and paper, rubber, grain, feed, food, and chemical processing industries. The company also makes rotary compressors, vacuum pumps, bin signals, motion safety switches, material feeders, and preheating and cooling equipment for the cement industry.

◆ ◆ ◆

The MW Protective Coatings Division of Metalweld, Inc., announces that all facilities connected with its new Scotts Lane Plant have been completed so that the company is ready to return to normal schedules on all phases of protective coating service, including application of rail tank car and tank truck linings and coatings, as well as work on ship and barge tanks, storage tanks, process, and similar equipment exposed to critical corrosion-contamination conditions. All types of protective coatings are applied in the plant—from synthetic resins and rubber linings to sprayed metal and specialty coatings. For information, write the company c o F. P. Walther Jr. and Associates, Inc., 172 Newbury St., Boston 16, Mass.

. . . the human element

. . . van Ameringen . . . Walker

The board of directors of van Ameringen-Haebler, Inc., supplier of raw materials to the perfume, cos-

Have You Paid

Your 1956

MEMBERSHIP DUES ?

Dues for

Professional Members and Members . . $7.50 per year

Student Members . $2.50 per year

Remit to:

INSTITUTE OF FOOD TECHNOLOGISTS
176 West Adams Street
Chicago, Illinois

metic, food, and soap industries, has elected **Mr. Arnold L. van Ameringen,** formerly president, board chairman, and **Mr. Chas. P. Walker, Jr.,** president and chief executive officer. Mr. Walker became an officer and director in February 1953, and has been serving as executive vice president. Previously, he had been general sales manager and a director of Chas. Pfizer & Co., Inc. Mr. van Ameringen will continue to devote his full time to the interest of the company which has increased its sales volume over 50% during the past three years.

◆ ◆ ◆

Dr. Balwant Rai Suri has joined Hagan Corp., Pittsburgh, Pa., as a research chemist, specializing in food processing. A graduate of Punjab University, India, IFT member Suri formerly was associated with the Directorate of Food Inspection, New Delhi, India, as a chief chemist; with the Ministry of Agriculture, Government of India, as a technical food processing officer; and with Great Northern Railway, St. Paul, Minn., as a chemist. He holds his Ph.D. in food technology from Oregon State College.

◆ ◆ ◆

Mr. Herbert J. Mossien has been named manager, and **Mr. Robert J. Sparling** assistant manager of the newly created Laboratory and Inspection Products Sales Department of Bausch & Lomb Optical Co., 635 St. Paul St., Rochester, N. Y. Other newly established departments of the firm's Scientific Instrument Sales Division and their managers are: Consumer Products Sales, **Mr. John F. Brandt;** Photographic and Defense Products Sales, **Mr. K. E. Reynolds;** Technical Products Sales, **Mr. M. H. Stevens;** District Operations and Sales Training, **Mr. R. C. Nixon;** Customer Service and Sales Quota, **Mr. John A. Robbins.** Mr. L. B. McKinley, vice president in charge of the Division, made the announcements.

. . . manager Mossien of B & L Optical

◆ ◆ ◆

Canning Machinery Division of Food Machinery and Chemical Corp., San Jose, Calif., has announced appointment of **Mr. Wm. P. Mitchell** as sales manager of its Canadian branch, Food Machinery of Canada, Ltd. The Canadian branch, located in Hamilton, Ont., is under the jurisdiction of the Division's Eastern Operation at Hoopeston, Ill. In his capacity, Mr. Mitchell will be responsible for all sales activities in Canada, excepting the provinces of Alberta and British Columbia which are handled by the Western Operation at San Jose. IFT member Mitchell is credited throughout the food processing industry for having introduced the use of steam flow in can closure, and the preparation of sliced canned apples with the vacuum steam process.

look for the symbol of the RETORT
YOUR GUARANTEE
OF MATCHLESS QUALITY,
PURITY, UNIFORMITY
Behind the symbol of the Retort stands three generations of family pride and "know-how" in Essential Aromatics, natural and synthetic flavors, perfumer's specialties. Made in the West's most modern plant. The Retort is your guide to dependability.
F. Ritter & Co.
Los Angeles 39, California
Branch Offices in Principal Cities

◆ ◆ ◆

Mr. Edw. J. Massaglia has joined Atlas Powder Company, Wilmington, Del., as assistant general manager of the Chemicals Division, it was announced by Mr. Ralph K. Gottshall, president. Mr. Massaglia formerly was vice president and director of Pfizer International, Inc., serving with that organization from 1951 to 1955. Atlas also sends word of the election to its board of directors of **Mr. Wilfred D. Gillen,** president of The Bell Telephone Company of Pennsylvania, and The Diamond State Telephone Company.

◆ ◆ ◆

Mr. Lee H. Clark, general manager of the Pennsylvania Salt Mfg. Company's Sharples Chemicals Division, has been named vice president of the parent company, according to Mr. Wm. P. Drake, president. It is understood his major duties will be concerned with corporate organization and planning functions.

(Continued on page 63)

Institute of Food Technologists

THE PROFESSIONAL SOCIETY OF FOOD TECHNOLOGISTS

The Institute of Food Technologists numbers among its active members leading scientists, technologists and engineers in the field of Food Technology.

The Institute invites your professional association with this select group of scientific and technological workers. Only those who are qualified by education, special training, or experience are extended this invitation.

Food Technology may be defined as the application of science and engineering to the production, processing, packaging, distribution, preparation and utilization of foods. Scientists, technologists and engineers engaged in Food Technology, executives, officials and supervisors under whose jurisdiction Food Technology operations are conducted, research investigators, teachers, and others working in the field of Food Technology, will find membership in the Institute worth many times its modest cost.

If you can meet the qualifications for membership, you owe it to yourself and to your business or profession to become a member.

OBJECTIVES

The Institute is a non-profit, professional, educational association to promote the application of science and engineering to the production, processing, packaging, distribution, preparation, and utilization of foods; it stimulates investigations into technological problems arising therein, it provides a medium for presenting and discussing the results of such investigations; it stimulates and provides means for the free interchange of technological information and ideas among food technologists; it promotes recognition of the role of food technologists in the technical direction of operations in these fields; all of these activities have the ultimate objective of providing better and adequate foods for mankind.

ORGANIZATION AND PROGRESS

Organized July 1, 1939, at Cambridge, Mass., with a membership of less than 100, the Institute has grown to more than 4,000 (1954). It is world-wide in scope, with members in North, Central, and South Americas, the Scandinavian countries, England, Holland, Germany, France, India, Australia, and New Zealand.

MEMBERSHIPS

Professional Members. Any person who is ethically qualified, and who has had training and experience in food technology, or any person who in the opinion of the Council is recognized as distinguished in the contributing sciences as they apply to foods, shall be eligible to be a Professional Member of the Institute. The minimum training which shall qualify a candidate for eligibility for Professional Member is, in general, graduation from a college, university, or similar institution in which he has majored in one or more of the sciences or branches of engineering associated with food technology. The minimum experience shall be three years experience in food technology. The Council may, at its discretion, waive any or all of the foregoing requirements in the case of a person who, thru long experience, has distinguished himself in the field of food technology.

Members. Any ethically qualified person, active in special or limited aspects of food technology, who is an administrator, director or executive under whose jurisdiction operations in food technology are conducted; or who is engaged in the dissemination of knowledge of food technology; or one whose work requires a general knowledge of the broad principles of food technology as it applies to the products, processes or equipment with which he or she is concerned; or one scientifically trained in and who has entered a career in food technology; shall be eligible to become a Member.

Student Members. Any ethically qualified person who has never been a Professional Member or Member of the Institute, who is registered as a student in an educational institution with at least Junior (third year) standing, who is a candidate for a Bachelor's or higher degree in one or more of the sciences or branches of engineering associated with food technology, shall be eligible for membership as a Student Member. This classification shall be his status only until the end of the calendar year in which he completes his schooling. When graduated and otherwise qualified as defined in the section on "Members," a Student Member may, upon application, be elected to Membership.

DUES

Professional Members and Members—$7.50 per year; Students—$2.50 per year. Dues include a subscription to Food Technology.

PUBLICATIONS

Food Technology, issued monthly, is the official journal of the Institute. It is published to advance the profession of food technology by disseminating the results of research and their practical application in industry. Contributors to its pages represent many fields of scientific and technological interest.

Food Research, published bi-monthly, is devoted to publication of the results of original investigations and occasional reviews in the fields of food and beverage technology, chemistry, and microbiology. Food Research is available to Institute members at the special rate of $7.50 per year.

REGIONAL SECTIONS

Where sufficient members (25 or more) live within commuting distance of a given point, a Regional Section may be established. Such Sections are able to hold meetings at more frequent intervals than the National group, thus affording the food technologists regular opportunities for an exchange of views and ideas with others in the area. There are presently 24 Regional Sections.

ANNUAL MEETINGS

Each year one of the regional sections acts as host to the Institute at an annual meeting. The program of this annual conference is designed to acquaint members with various phases of food production, processing and distribution, and to keep them abreast of current trends and technological developments. The speakers invited are those whose subjects will build a well-rounded program, of interest to the greatest number. Annual conferences are highlighted by exhibits of new equipment, processes and special ingredients.

AWARDS

The society administers the following awards:

NICHOLAS APPERT AWARD (Medal). Each year the Chicago Section of the Institute makes this award to a person whose contributions to the food industry make him distinguished and outstanding in the opinion of the national jury.

BABCOCK-HART AWARD ($1,000.00). The purpose of this award, made by the Nutrition Foundation, is to encourage contributions to Food Technology which will have an influence on the nutritional well-being of the general population.

FLORASYNTH FELLOWSHIP AWARD. $1,000 granted annually to a young man or woman under 35 years of age, engaged in senior undergraduate or graduate work, as a candidate for an advanced degree, in recognized educational institutions in the United States or Canada, which is conducting fundamental investigations for the advancement of Food Technology.

GENERAL FOODS FELLOWSHIP AWARDS. Three Fellowships will be granted annually—no more than two to the same educational institution for the same calendar year, but will be renewable upon application to and approval by the Awards Committee of the Institute for a maximum of three years, in order to provide for continuity of studies leading to a doctorate degree, if the candidate so plans. However, candidates, who plan only a year of research after obtaining the Bachelor Degree, or who plan to read for a Master's Degree, will not be excluded from these fellowship grants. Each Fellowship is worth approximately $4,000.

GERBER BABY FOODS POST-DOCTORATE FELLOWSHIP AWARD. This Fellowship to promote research in some newer phase of food technology is worth $6,000.00 per annum and may be renewed for an additional year.

FOOD INDUSTRY TOPICS

(Continued from page 61)

Dr. Buell W. Beadle, outstanding authority in biochemistry and plant, animal, and human nutrition, has joined Southwest Research Institute, 8500 Culebra Rd., San Antonio, Texas, as manager of biochemistry research. IFT member Beadle came to his new post from the George W. Gooch Laboratories, Los Angeles, Calif., where he was executive vice president and general manager of the laboratories serving the feeds, foods, fertilizer, and fats and oils industries. He has served as head of staff of the U. S. Naval Ordnance Station in China Lake, Calif., and was research chemist in charge of physical and analytical chemistry at American Meat Institute Foundation, Chicago, for six years. He is co-author of the book, *Methods of Vitamin Assay*, and has published many articles in his field. Among his patents are several for antioxidants for fats, oils, and fatty foods, and one in the field of high frequency dielectric processing of foods.

. . . Beadle comes east to Southwest Research Institute

◆ ◆ ◆

. . . Pitman of Western Waxed Paper's PR & DL

Crown Zellerbach Corporation announces that **Mr. Gilbert A. Pitman,** a member of IFT, has joined the staff of Packaging Research and Development Laboratory of Western Waxed Paper Division, San Leandro, Calif. Mr. Pitman, who has had 27 years' experience as food technologist and packaging engineer, most recently was executive officer and secretary of the Western Fresh Fruit & Vegetable Container Institute which terminated its activities in August 1955.

◆ ◆ ◆

Food Research Laboratories, Inc., 48-14 33rd St., Long Island City, N. Y., announces appointment of **Miss Betty J. Means** to its staff in microbiology. Miss Means comes to Food Research from Merck & Co., where for a number of years she supervised the sterility testing program in the control laboratories of that company.

◆ ◆ ◆

Mr. Raymond Stevens, senior vice president of Arthur D. Little, Inc., Cambridge, Mass., has been unanimously chosen to receive the 1956 Gold Medal of The American Institute of Chemists. The award is in recognition of his "contributions to the wider understanding of essential procedures for the management and operation of industrial research." Presentation will be made during the Institute's annual meeting, May 9-11, 1956, at the Hotel Statler, Boston, Mass.

◆ ◆ ◆

Dr. John A. Keenan announces appointment of **Mr. Harold A. Ham** to a newly created position of general manager in charge of manufacturing at Stan-

Advertisers' Index

American Can Company	37
American Cyanamid Company	14 and 15
American Maize Products Company	27
American Optical Company	53
Ass'n of American Soap & Glycerine Producers, Inc.	41
Cadillac Employment Agency	64
Continental Can Company	32 and 33
Diamond Crystal Salt Company	31
Distillation Products Industries	28 and 29
Dodge & Olcott, Inc.	13
Eastman Chemical Products, Inc.	55
Felton Chemical Company, Inc.	39
Firmenich, Inc.	9
Florasynth Laboratories, Inc.	43
Food Development Laboratory	64
Food Machinery & Chemical Corporation	1
Food Research Laboratories, Inc.	64
The Foxboro Company	34
Fries & Fries, Inc.	42
Fritzsche Brothers, Inc.	7
Givaudan Flavors, Inc.	25
The Griffith Laboratories, Inc.	3rd Cover
Hoffmann-La Roche, Inc.	2
Johns-Manville Corporation	47
Kelco Company	17
H. Kohnstamm & Company, Inc.	19
Magnus, Mabee & Reynard, Inc.	38
Morton Salt Company	49
Neumann-Buslee & Wolfe, Inc.	2nd Cover
Niagara Blower Company	35
Norda Essential Oil & Chemical Company	4th Cover
Chas. Pfizer & Company, Inc.	23
Polak & Schwarz, Inc.	46
Proctor & Schwartz, Inc.	5
F. Ritter & Company	61
Rohm & Haas Company	21
Schwarz Laboratories, Inc.	64
Scaplant Chemical Corporation	59
A. E. Staley Manufacturing Company	22
Sterwin Chemicals, Inc.	57
Sunkist Growers, Inc.	51
U. S. Steel Corporation	45
van Ameringen-Haebler, Inc.	11
Wallace & Tiernan Company, Inc.	58
Wisconsin Alumni Research Foundation	64

FOOD INDUSTRY TOPICS

dard Packaging Corporation's Flex-Vac Division, Clifton, N. J. Mr. Ham previously was director of pharmaceutical production with Hoffman-La Roche, general factories manager with Lehn & Fink, and assistant to the vice president in charge of operations at Pepsi-Cola Bottling Co. He assumes the former duties of **Mr. H. T. Holbrook** who has been appointed to a new position as vice president in charge of the firm's expansion and growth in packaging and its related field.

◆ ◆ ◆

Mr. Fred W. Hoover, Jr., has been elected executive vice president of Albers Milling Co., Los Angeles, a subsidiary of Carnation Co. Mr. Hoover was made a vice president of Albers a year ago, and also is a director of the firm.

◆ ◆ ◆

Mr. Clement H. Watson has been appointed general manager of General Foods' Atlantic Gelatin division at Woburn, Mass., it was announced by Mr. Geo. Hampton, executive vice president. He succeeds Mr. Joseph H. Cohen, retiring vice president and general manager.

◆ ◆ ◆

Irving Trust Company, New York City, announces election of **Mr. Thomas C. Fogarty,** new president and a director of Continental Can Co., to its board of directors.

Mr. Daniel C. McCoy, consulting engineer, 7546 Normandy Lane, Dayton, O., and a long-time member of IFT, now is providing consultation services on the technical phases of refrigeration for commercial and industrial uses, on the handling, transporting, and storing of perishables — with special attention to frozen foods, and on electronic heating and communications problems. Mr. McCoy recently retired from the Frigidaire Division of General Motors Corporation after 30 years of service.

. . . after 30 years, consulting for McCoy

◆ ◆ ◆

At the annual meeting of the Canadian Packaging Assn., **Mr. Berkley V. Schaub,** vice president and director of National Adhesives (Canada) Ltd., was elected president of the Association for 1955-56. He had served previously as first vice president of the Association.

◆ ◆ ◆

Mr. Grover Steffen, of the M. Steffen Co., Chicago, and a member of IFT, has been elected president of the recently organized Vinegar Institute. The Institute is the result of the expansion of the Cider Vinegar Institute, a national trade association since 1946.

EMPLOYMENT NOTICES

FOOD TECHNOLOGISTS

An active, confidential service: Interview at your convenience. Call, write or wire:
Gladys Hunting (Consultant)
Drake Personnel, Inc.
Room 628
HArrison 7-8600
220 S. State St., Chicago 4, Ill.

WANTED: FOOD TECHNOLOGIST. For research and development work by food processor in Chicago. Good opportunity for advancement in rapidly expanding, well-established concern. Require S.B. degree, preferably under 30. Send resumé to BOX 448, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

WANTED: Food Technologist. Willing to settle in Detroit to set up production control and assume managerial position in a sound growing organization. Good salary and unusual opportunity for an ambitious man. Citrus experience helpful. REPLY BOX 457, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

WANTED: Food Technologists and Chemists with advanced degrees and experience for research and development positions in an interesting and expanding food industry. Only superior type personnel will be considered. REPLY BOX 454, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

BAKING SUPERVISOR
JUNIOR CHEMIST

Two positions — Baking Supervisor and Junior Chemist—with producers of Swan Down Cake Mixes, offering broad opportunity for advancement. BAKING SUPERVISOR must have cereal chemistry degree with experience in Prepared Mixes, Angel Food and shortening cake baking, and donut frying. Will supervise control baking lab. JUNIOR CHEMIST must have degree in chemistry or cereal chemistry. Will test wheat, flour and all ingredients used in large scale prepared mix production. Fine benefits and working conditions offered only by General Foods Corporation. Write, giving full resumé including salary desired to Igleheart Brothers, Jell-O Division, General Foods Corporation, 1600 First Avenue, Evansville 7, Indiana. Attention: Mr. J. C. West.

PRODUCTION CONTROL SERVICES
Vitamin D rat assay — results in 8 days • U.S.P. or A.O.A.C. vitamin A assays • Other vitamin assays • Antibiotic and amino acid assays • Sodium determinations • Proximate analyses and mineral determinations. • Pharmacology including warm-blooded toxicity studies • Specific immune sera • Enzyme investigations • Insecticide Testing and Screening
Other biological, chemical, and microbiological services.
Project Research and Consultation.
WISCONSIN ALUMNI RESEARCH FOUNDATION
P.O. Box 2059-S • Madison 1, Wisconsin

FOOD RESEARCH LABORATORIES, INC.
Founded 1930
RESEARCH
ANALYSES • CONSULTATION
Biological, Nutritional, Toxicological Studies
for the Food, Drug and Allied Industries
48-14 33rd STREET, LONG ISLAND CITY 1, N. Y.

Schwarz
SERVICES TO THE FOOD INDUSTRIES
• Consultation on Food Problems.
• Analyses of food materials and products.
• Food plant design, process examination and control.
• Legal testimony and consultation on government regulations.
Founded 1867
Write for bulletin "Scientific Quality Control of Foods and Beverages"
SCHWARZ LABORATORIES, Inc.
230 Washington St., Mount Vernon, N. Y.

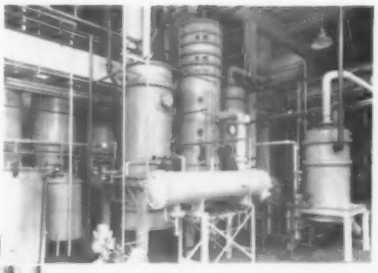
FOOD DEVELOPMENT LABORATORY
S. W. ARENSON
Director
2865 West Franklin St.
Baltimore 23, Md.
440 W. 24th St.
New York, N. Y.
Ingredient evaluations • New products development — flour, shortenings, milk and other basic ingredients • Chemical and physical laboratory, bakery, spray dryer and other unit process equipment.

SOLUBLIZED *Pepperoyal*®

Hi-Fi Flavor

In seasonings, as in recorded music, "HI-FI" denotes a definite and enjoyable difference in quality.

Compare Griffith's Solublized PEPPEROYAL with any soluble pepper. Compare it for purity of flavor! . . . for potency of flavor! . . . for uniformity of flavor! You'll find the flavor of PEPPEROYAL exceptional—constantly and exclusively "HI-FI" in quality. That's an important advantage to you as a user.



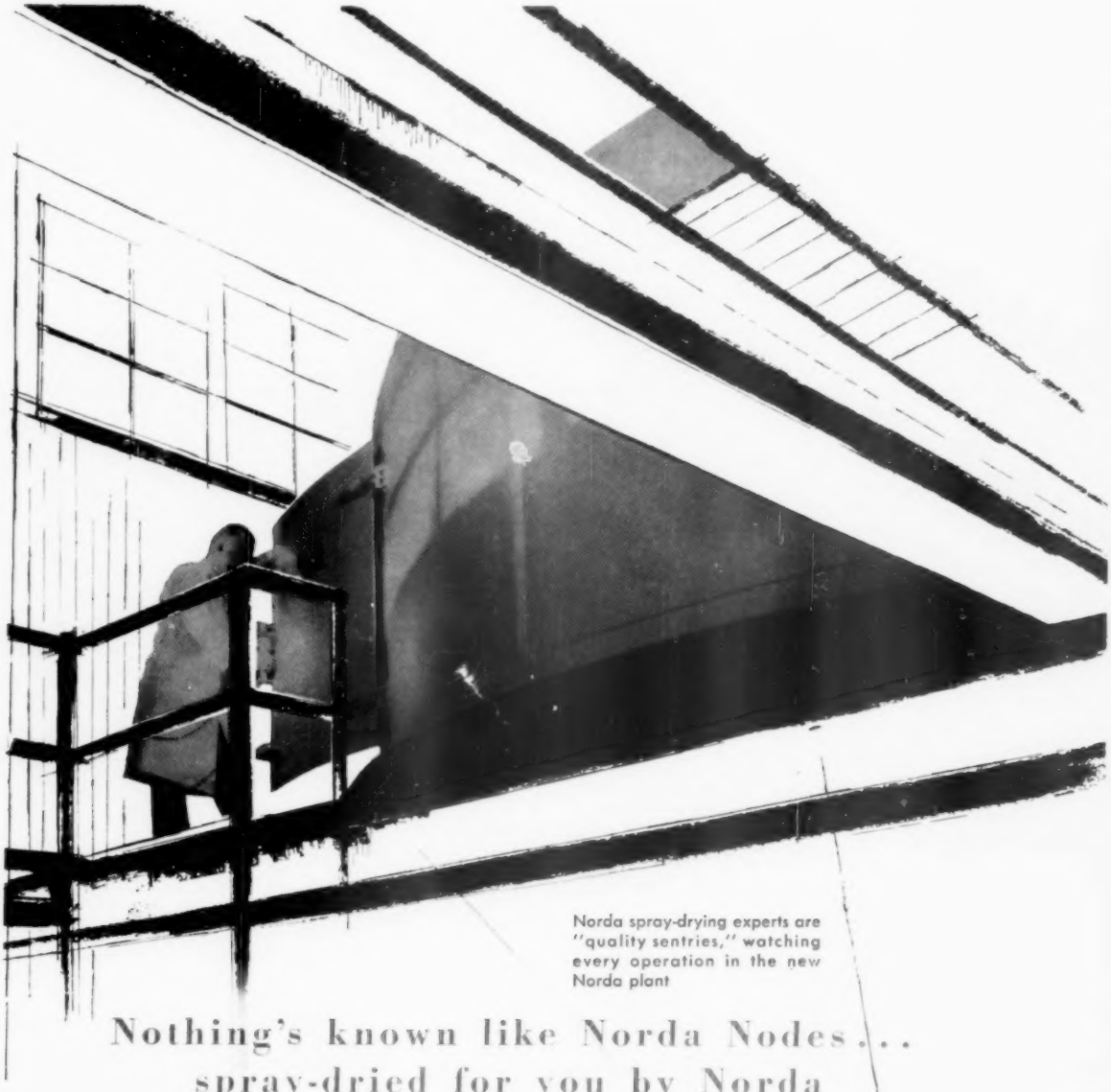
"High Fidelity" Flavor naturally comes from prime quality spices. But, its real distinctiveness originates here with The Griffith Laboratories' exclusive process of controlled flavor extraction.

THE *Griffith* LABORATORIES, INC.

In Canada—The Griffith Laboratories, Ltd.

CHICAGO 9, 1415 W. 37th St.
NEWARK 5, 37 Empire St.
LOS ANGELES 58, 4900 Gifford Ave.
TORONTO 2, 115 George St.

Laboratorios Griffith do Brasil, S. A. — Caixa Postal 300 Mogi das Cruzes, Est. S. P., Brasil



Norda spray-drying experts are "quality sentries," watching every operation in the new Norda plant

Nothing's known like Norda Nodes... spray-dried for you by Norda

You really should look into the possibilities which Norda Nodes offer you.

Norda Nodes are true flavors, imprisoned and locked in very tiny flavor buds, by Norda's most modern methods of superior spray-drying. A colloid coat protects Norda Nodes; it dissolves instantly in liquids, flooding foods made from your mixes with fresh, true, unfading, long-lasting pure fruit flavors. Norda's *in-blown* excellence gives *in-grown* richness to a great range of profitable products.

Put Norda Nodes through your most demanding quality tests. Ask on your business letterhead for *free samples* today.

"Flavor it with a Favorite"
—Norda Nodes

Norda®

601 West 26th Street,
New York 1, N. Y.

CHICAGO • LOS ANGELES • SAN FRANCISCO • TORONTO • MONTREAL • HAVANA • LONDON • PARIS • GRASSE • MEXICO CITY